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The Arrowrock Dam, Boise Irrigation Project, U. S. Reclamation Service

By Chas. H. Paul*

The Arrowrock Dam, about 351 ft. in height, which will effect the storage of water in the Arrowrock Reservoir for the Boise Project of the U. S. Reclamation Service, will be located in the cañon of the Boise River, about 20 miles above the city of Boise, about two miles above the old Highland Dam, and about four miles below the mouth of the South Fork (see Fig. 3). The old wagon road to Twin Springs passed directly through the damsite. The cañon at this point is fairly narrow, with high, steep, bare granite cliffs on the north side, and on the south side a less precipitous slope, covered for some distance by a cap of lava which rises almost perpendicularly from its contact with the granite, about 20 ft. above the water surface, to a height of about 50 ft. The top of this lava bench is nearly level and, like the granite slope above it, is covered with a thin layer of earth, and some vegetation. This cap of lava, hanging, as it were, on the granite slope, is all that is left of a flow that at one time undoubtedly obstructed the river channel to the height now indicated by the top of the bench.

The Arrowrock site (see the two half-tone views and the two line drawings) was selected after several years of general investigations and several months of detailed study. The Boise River, as is well known by those who have studied it carefully, while remarkably well supplied with dam-sites, is sadly lacking in reservoir sites. Where the few otherwise desirable reservoir sites do occur they either are located too far up the river to be assured of an adequate water supply, or are too small to be of much value, or are handicapped by the absence of the required dam-site. A study of the irriga-

*Construction Engineer, U. S. Reclamation Service, Arrowrock, Idaho.

Site of the Arrowrock Dam, Boise Irrigation Project, U. S. Reclamation Service, Near Boise, Ida.

(Looking upstream, showing outlet end of diversion tunnel. The top of the damis at the elevation indicated by the letter X just in front of the cableway tower on the right. The north abutment is just back of the rocky cliff at the left-hand side of the picture.)

tion needs of the Boise Valley and the hydrograph of the river leads to the conclusion that all the water that it is practicable to store should be conserved, and that during some low years even the whole flow of the river is hardly sufficient to meet the demands.

The storage problem sifted down to one of two alternatives. Either to build enough small reservoirs on the several branches of the river to store practically all the low-year flood waters of these branches, or to build one large reservoir far enough down on the river to catch the flow from all the main tributaries. Preliminary estimates indicated that the latter scheme, with a reservoir at the junction of the South Fork with the main river, would be the most economical, both for first cost and for future operation and maintenance; this scheme has the added advantage of closer proximity to the heads of the canals and the land to be watered, insuring quicker action and less loss of water in times of scant supply. For this reservoir, which is now known as the Arrowrock Reservoir, two dam-sites have been investigated, one at Hellgate, about one mile below the mouth of the South Fork or three miles above the Arrowrock site, and the other at Arrowrock. The Arrowrock site presented fewer difficulties of construction, more favorable foundation, and less probable cost for the same storage capacity.

Early in the investigations it was realized that an extremely high dam would be required to secure the necessary storage, and before the plans were past their preliminary stage it was seen that the Arrowrock Dam, if built to the height required, would have the distinction of being the highest in the world.

FIG. 1. ARROWROCK DAM-SITE, NEAR BOISE, IDA., LOOKING DOWNSTREAM

(Inlet end of diversion tunnel and partly completed coffer-dam in foreground; outlet end, just beyond bridge. Top line of dam at each end shown by letter X.)

RAILROAD—As soon as the construction of the Arrowrock Dam was decided upon, immediate steps were taken to improve the transportation facilities from Barberton, the nearest railway station, to the site of the work. Several preliminary surveys for a railroad had already been made and the line that seemed to be the most feasible followed, from Barberton, the north side of the river to Goose-neck, a distance of nine miles, where it crossed the river to the south side, passing through Kunzi's and Dowling's ranches, and close by the south end of the Highland Dam to a point a short distance below the Arrowrock damsite, where the yards are located. From here a spur is continued on the south side to the damsite, and a second river crossing takes another spur through the construction camp to the north end of the dam. As soon as the right-of-way had been acquired, the grading of the roadbed was commenced and track laying followed as fast as practicable. This railroad was completed to Arrowrock on Nov. 9, 1911, and since that time daily trains have been operated for freight and passenger service between Arrowrock and Barberton. Since Dec. 20, 1911, the Oregon Short Line has run a daily train from Boise connecting with the Arrowrock train at Barberton. The Arrowrock Ry. is standard gage, 17 miles long, with maximum grade of 1½% and maximum curvature of 12°, and is the only railroad in the United States built and operated by

the government. There are two river crossings, one at Gooseneck, which consists of two 150-ft. through spans, and one at Arrowrock, consisting of four 68-ft. deck spans, both of the Howe type.

WAGON ROAD—Pending the construction of the railroad, it was necessary to do considerable work on the old wagon road, in order that the cost of freighting might be kept down to a reasonable figure. A piece of road about two miles long was built also from Gooseneck, connecting the old stage road just above Highland Valley to be used after the railroad had reached Gooseneck and while the upper end of the railroad and the two river crossings were being constructed. The old highway to Twin Springs passes through the reservoir site for a distance of 10 or 12 miles above Arrowrock. A new road, to replace this old one, is being built around and above the flow line and this new road is completed as far as Cottonwood Creek, a distance of about 10 miles by the new location. About five miles of road up Cottonwood Creek has been rebuilt to facilitate hauling of lumber from a government sawmill, which has been located on that creek about seven miles above its mouth.

CAMP—A construction camp for the accommodation of 800 to 1000 men is being built at Arrowrock and is now practically completed. Practically all the lumber for this camp has been cut at the Cottonwood sawmill, which was set up and put into operation as early last spring as weather conditions would permit. This mill will also get out all the lumber needed for construction purposes at the dam, and will be a great convenience inasmuch as any special arrangements for delivery of rush orders, or special requirements may be made on short notice. The principal camp buildings are: A large warehouse, which is kept stocked with all articles needed on the work. This stock is issued upon requisition to the foremen on the work, and to the mess, mercantile store, machine shop and tool house; a mercantile store which is kept stocked with all articles needed to supply the personal wants of the men and families on the work; a mess house that will accommodate 750 men at one sitting, and in which were served more than 50,000 meals during the month of December, 1911; bunk houses and dormitories; an office building; a fully equipped machine shop; a stable that will house about 70 horses; a bath house and laundry; a club house where the men may spend their leisure hours in reading or enjoying the various games provided for their recreation; a hospital under the charge of a resident physician assisted by two trained nurses, where cases of accident or sickness are cared for; and several cottages which are rented to the principal employees having families.

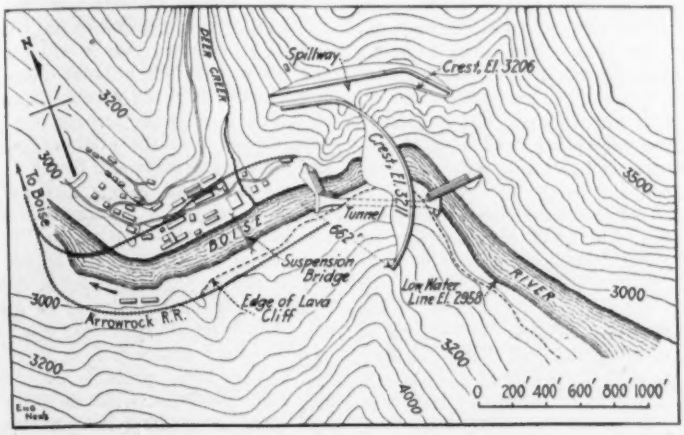

FIG. 2. GENERAL PLAN OF ARROWROCK DAM-SITE AND CONSTRUCTION CAMP

The water supply is taken from Deer Creek, which flows through the camp. A small storage reservoir and diversion dam have been built about 1¼ miles above camp, from which the water is taken through a covered flume into a storage tank located on the hill just above the works and at an elevation about 350 ft. higher than the buildings. A 6-in. main of wood-stave pipe distributes the water around camp and hydrants are placed at such locations that at least two standard fire streams under more than 100 lb. pressure can be put onto any building. A complete sewerage system, including a septic tank, has also been installed and strict watch is kept of sanitary conditions, to the end that the general health of the camp may be kept as good as possible. The principal buildings are heated by steam from a central heating plant.

TELEPHONE SYSTEM—The Twin Springs toll line of the Bell telephone system passes through the camp, and a toll station is maintained at the Arrowrock office. A government line has also been built from the Boise office of the Reclamation Service to the Arrowrock office, following, in general, the line of the railroad and connecting up the various construction camps, warehouses and forwarding stations along the line. At Arrowrock a central station is maintained from which local lines are run to the desks of the principal men in the office, to the warehouse, store, mess, shops, etc., to several convenient points over the work, and to the residences of the principal engineers and construction men.

POWER PLANT—On account of the high cost of coal, the expense and inconvenience of providing for extensive storage, and the uncertainty of obtaining the necessary supply during all seasons for the operation of the construction plant, electric power will be used in so far as practicable. For the purpose of supplying this power, a 1500-kw. plant is being constructed at the Boise Diversion Dam, about 15 miles down the river from Arrowrock, where a fall of about 25 ft. is obtained. This plant consists of three Allis-Chalmers 725-hp. hydraulic turbines, each direct-connected to a 625-kv.a. generator. This machinery will be housed in a reinforced-concrete building, for it is believed that this power house will be a valuable asset to the project after the construction work at Arrowrock is completed. The construction of this plant is well advanced and it will be put into operation within the next few days.

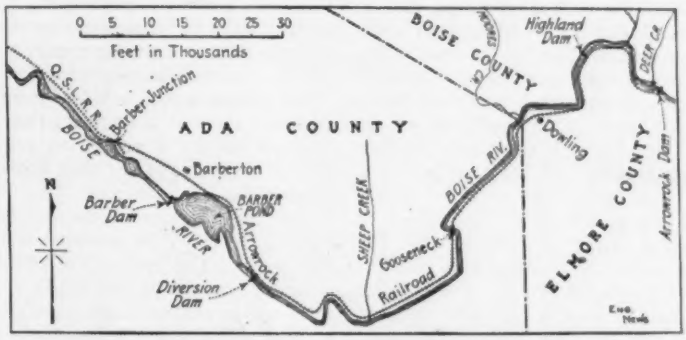

FIG. 3. LOCATION OF ARROWROCK RAILROAD, BOISE IRRIGATION PROJECT, IDA., SHOWING LOCATION OF ARROWROCK DAM AND ACCESSORIES

Two 23,000-volt transmission lines will carry the power from this plant to Arrowrock, duplicate lines being used to insure continuous service in case of trouble on one of the lines. Both of these lines are built and in operation, and power is being obtained temporarily from the local company.

CONSTRUCTION PLANT — Considerable study is just now being given to construction plant and some of the equipment to fill the earlier requirements is already on the ground. A 70-ton Atlantic steam shovel is in operation along the north side of the river just above the water line, removing the loose material that has been cleaned off from the north abutment and some that has been thrown down from the opening up of the spillway excavation. This shovel will be used later for the excavation of the spillway trench. Two 15-ton Lidgerwood cableways, each of about 1500 ft. span, are on the ground. The towers for these cableways are erected and the erection of the cableways themselves is nearly completed. Four 10-ton American stiff leg derricks and hoists have been purchased. Several smaller derricks are already on the work and some of them are now in use. A drag-line excavator with 2½-yd. bucket is on the work and in process of erection. A screening and crushing plant to handle the material from the excavation and prepare it for use in concrete is being assembled, and the designs for the concrete mixing plant are practically completed. Equipment for the pumping plant for unwatering the excavation is being purchased. Bids have been received recently for crushing and grinding machinery for a sand-cement plant.

DIVERSION WORKS—One of the first and most important problems that confronted the engineers in planning the work was the method of taking care of the river during construction. After working out several different schemes in detail, it was decided to divert the river through a large tunnel under and below the lava bench at the south end of the dam. This tunnel is constructed entirely through granite, and has a cross-section 30 ft. wide and 25 ft. high, the arched top having a 10-ft. rise. The length of the tunnel proper is about 470 ft. The bottom and sides are lined with concrete and the arch with timber. The entrance is effected through a carefully designed bell mouth and every effort has been made to secure a smooth and symmetrical entrance, so as to use up as little head as possible (for the maximum velocity will be about 30 ft. per sec.) and to avoid eddies, cross-currents, etc., in order to secure the greatest possible capacity. A bell mouth at the outlet end has been built also with the idea of saving head again as the water passes from the tunnel into the river channel below the work. Timber crib, rock-fill cofferdams, with sheet pile cut-offs below the river bed divert the water into the tunnel at the inlet, and protect the work against back water at the lower end. The ordinary maximum floods in the Boise River at this point reach from 15,000 to 18,000 sec.ft. The estimated capacity of the diversion works is 20,000 sec.ft., and the coffer-dams are designed to withstand overflow in case an extraordinary flood occurs during the construction period. The other features of the work below river bed will be arranged to meet this contingency, if it occurs. The construction of the tunnel proper is completed and the bell mouths and coffer-dams are finished as far as they will be carried until after the spring flood of this year. This flood will be carried partly through the tunnel and partly in the old river channel. As soon as the flood passes, the entire river will be diverted through the tunnel and the coffer-dams will be completed.

EXCAVATION — The foundation of the dam has been explored by means of about 60 diamond-drill holes yielding cores from 20 to 50 ft. into the bedrock, supplemented by numerous test pits, shafts, and tunnels above the water line. The foundation is a good quality of hard granite nearly 90 ft. below the river bed at the deepest place and averaging about 65 to 70 ft. over most of the area. The area covered by the foundation of the dam will be about an acre, from which it will be seen that this excavation will be no small item in the construction of the dam. Sheeting and bracing to hold the slopes is out of the question on account of the size and depth of the hole. Excavating and concreting small sections is objectionable on account of the necessarily slow progress, great expense and the added danger of being driven out by extraordinary floods if the work below the water surface is prolonged. On the other hand an enormous amount of pumping will probably be required if the whole excavation is opened up at once.

The scheme which is looked upon with the most favor at the present time is to excavate enough to permit the construction of a section of the dam across the river along the upstream face heavy enough for a gravity section with the top about 20 ft. above the present surface of high water. This section will afford additional protection against floods, will require only a portion of the excavation to be done at first and will cut off the seepage from the upstream side, allowing the remainder of the work below the river bed to be done under much more favorable conditions. The diversion works will be completed so that the excavation may be started immediately after the June flood of this year. The total amount of excavation below the river bed, as at present estimated, will be about 225,000 cu.yd.

THE DAM—The dam itself will have a total height of about 351 ft. from the lowest point of the foundation to the roadway along its crest, which will be guarded on either side by a parapet wall 3½ ft. high. It will be built with a gravity section, but the usual factors of safety will be increased by giving it a curve in plan, to a radius of 662 ft. The length of the crest will be 1060 ft. A line of holes will be drilled into the foundation just inside the line of the upstream face to a depth of 30 or 40 ft., and grouted under pressure, if possible, although present indications are that the rock is so compact that it will not take any grout. A line of open holes just downstream from the grouted holes will be driven to catch any seepage that might possibly get past the pressure grouting and these weep holes will be led up into a large inspection tunnel that will run the entire length of the dam just above the normal high-water surface of the back water. An outlet will be provided so that any seepage that may accumulate in the inspection tunnel may be drained out. The exact dimensions of this tunnel have not been determined as yet, but it will be very large, probably 20 or 30 ft. high and of sufficient width so that a drill equipment or grouting machine may be set up and operated inside if there is indication at any time after the reservoir is filled that any further treatment of the foundation is advisable.

The dam will be constructed of rubble concrete with as many boulders incorporated as can be done economically and without delay to the work—probably about 20% of the whole mass. About 520,000 cu.yd. of masonry will be required to complete the structure.

Outlets will be provided at several different elevations and, starting with a full reservoir, the upper ones will be put into commission first, and the lower ones opened up as the water level drops, so that it will not be necessary to operate any of the gates under very great heads. Provision will be made also for the future construction of a power house, in case it may be considered advisable, later, to develop power at this site.

SPILLWAY—A spillway with a capacity of 40,000 sec.ft. will be built at the north end of the dam with a concrete lip about 400 ft. long following the contour of the ground in a direction generally at right angles to the line of the dam. The water will fall over this lip into a concrete-lined trench parallel to it, by which means it will be carried well by the end of the dam and allowed to cascade over the granite cliffs into the cañon of Deer Creek which will take it back into the river. It is believed that 40,000 sec.ft. will more than cover any flood that will occur at this point on the river. The upper set of outlet gates may be used in connection with the spillway, if necessary, and will take care of an additional 10,000 to 15,000 sec.ft., and the dam will be built so that water may flow over it for a depth of 2 or 3 ft. without endan-

gering the structure. The excavation for the spillway will amount to about 350,000 cu.yd., a large part of which, it is expected, will be used in the masonry of the dam as sand, crushed rock and boulders. The work of benching in for the spillway lip is now under way. Enough material will be removed at this time to provide against danger to the men when the excavation for the dam is opened up, after which the progress of the spillway excavation will be regulated by the rate at which material is needed for concrete.

This work is being carried on under the general direction of F. E. Weymouth, supervising engineer of the U. S. Reclamation Service for the Idaho District. The writer is construction engineer in charge of the Arrowrock Dam and related features. James Munn is superintendent of construction.

NOTE — The material presented here was read originally before the Idaho Society of Engineers at its September, 1911, meeting, and has been revised and brought down to May, 1912.

Bituminous Roads in 1911*

By Arthur H. Blanchard†

The author reviews the use of bituminous materials in the construction and maintenance of American highways in the year 1911. Besides summaries of general practice, yardages for eight states, classified by material and methods, are given and a statement of recent practice with reference to patents on bituminous macadam mixtures.

*A paper presented at the Washington Meeting of Section D of the American Association for the Advancement of Science, December, 1911.

†Professor of Highway Engineering, Columbia University, New York City.

In December, 1910, the writer presented before the American Association for the Advancement of Science a paper entitled "The Present Status of the Use of Bituminous Materials in the Construction and Maintenance of Roads in the United States," which treated of the status of the art and science of this branch of highway engineering during 1908, 1909 and 1910. The development during 1911 of the use of bituminous materials is worthy of consideration. This review will not be confined to county and state road construction, but will also include a consideration of municipal work.

The review will be presented under the following headings: (1) A general statement covering the magnitude of the work accomplished by some of the prominent state highway departments, (2) progress in the construction of bituminous surfaces and the use of palliatives, (3) the construction of bituminous pavements by penetration methods, (4) the present status of bituminous concrete pavements in the United States, (5) the development of sheet asphalt pavements in municipalities.

DEFINITIONS — As considerable confusion arises because of misunderstanding of the various expressions and terms used in describing materials and methods of construction, certain definitions are given in order that the content of the descriptions as set forth below may be manifest to all. The nomenclature used in this paper covering bituminous materials and their use in the construction of roads and pavements follows:

ASPHALTS are solid or semi-solid native bitumens, solid or semisolid bitumens obtained by refining petroleums, or solid or semisolid compounds which are combinations of the bitumens mentioned with petroleums, or derivatives thereof, consisting of a mixture of hydrocarbons of complex structure, largely cyclic and bridge compounds, melting upon the application of heat.

ASPHALTIC PETROLEUMS are petroleums which yield asphalts upon reduction.

ASPHALT CEMENT consists of an asphalt, pure or mixed with foreign matter, which may or may not be fluxed with petroleum residuums.

BITUMENS are mixtures of native or pyrogenous hydrocarbons and their nonmetallic derivatives, which may be gases, liquids, viscous liquids, or solids, and which are soluble in carbon disulphide. This definition was proposed by Committee D-4 of the American Society for Testing Materials.

BITUMINOUS CONCRETE PAVEMENTS are those having a wearing surface composed of stone, gravel, sand, shell or slag or combinations thereof and bituminous materials incorporated together by mixing methods.

BITUMINOUS GRAVEL PAVEMENTS are those composed of gravel and bituminous materials incorporated together by penetration methods.

BITUMINOUS MACADAM PAVEMENTS are those consisting of broken stone and bituminous materials incorporated together by penetration methods.

BITUMINOUS SURFACES consist of superficial coats of bituminous materials with or without the addition of stone or slag chips, gravel, sand or materials of a similar character. This definition was proposed in the 1912 Report of the Special Committee on "Use of Bituminous Materials in Road Construction" of the American Society of Civil Engineers.

SHEET ASPHALT PAVEMENTS are those having a wearing surface composed of a predetermined graded sand, fine material and asphalt cement incorporated together by mixing methods. Although this definition embodies the ideas of the leading authorities and covers common usage, it has been inserted because it has been claimed that a bituminous concrete containing as part of its mineral aggregate broken stone passing a ½-in. sieve and retained on a ¼-in. sieve should be classified under sheet asphalt pavements. Fortunately this assertion has not been received with favor by municipal engineers.

CONSTRUCTION IN EIGHT STATES—In order to give some idea of the extent of the use of bituminous materials in the construction of roads and pavements in the United States, the superficial yardage of roads maintained by surface treatments, of bituminous pavements constructed by penetration methods and of bituminous concrete pavements built under the jurisdiction of the State Highway Departments of Maine, New Hampshire, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania and Maryland during 1911 is given. In the following table the yardage for 1908, 1909 and 1910 is included for comparison.

BITUMINOUS ROAD TREATMENT AND CONSTRUCTION IN EIGHT STATES IN 1908-11, INCLUSIVE

	Tars and tar asphalt compounds	Medium and heavy asphaltic oils and asphalt cements	Light asphaltic oils
Surface treatment of roads			
1908.....	57,700	239,500	.....
1909.....	95,500	910,600	4,125,900
1910.....	123,400	2,434,200	9,890,400
1911.....	433,700	7,980,400	3,765,200
Bituminous Pavements constructed by penetration methods			
1908.....	37,800	25,200	.....
1909.....	170,200	2,077,400	.....
1910.....	339,300	4,840,200	26,500
1911.....	121,900	8,680,900	.....
Bituminous Concrete Pavements			
1908.....	52,100	4,400	.....
1909.....	136,000	219,500	.....
1910.....	158,000	432,600	.....
1911.....	24,400	508,100	.....

As under the Rhode Island State Board of Public Roads no construction work was accomplished during 1911, due to the fact that no road appropriation was made by the legislature, the yardage of bituminous concrete pavements constructed with tar and tar-asphalt compounds in 1911 shows a decrease in comparison with the yardage recorded for 1908, 1909 and 1910, the bulk of which was built by the Rhode Island Board. It is of interest to note, however, that 750,000 gal. of refined tar have been ordered to be used in the construction of bituminous concrete pavements in Rhode Island during 1912.

That more permanent forms of construction are favored by our State Commissions is clearly shown by the marked decrease in the use of light oils for surface treatment of roads and the decided increase in the surface treatment of roads with heavy asphaltic oils and

asphalt cements. As showing the general increase in the use of bituminous material in the construction of bituminous surfaces and bituminous pavements from 1908 to 1911, the total figures for the four years are given in Table II.

TABLE II. TOTAL AREA OF BITUMINOUS ROAD TREATMENT OR CONSTRUCTION IN EIGHT STATES, 1908-11, IN SQUARE YARDS

	Total	Omitting use of light asphaltic oils
1908.....	416,700	416,700
1909.....	7,735,100	3,609,200
1910.....	18,244,600	8,327,700
1911.....	21,514,600	17,749,400

The first column of yardage includes the road surface treated with light asphaltic oils. A comparison of more value and representing material progress along the lines of improved methods of construction and maintenance should be based on totals from which the yardage of road surface treated with light asphaltic oils is omitted, as shown by the last column of Table II.

As noted above, one line of development in the surface treatment of roads has been the departure from the use of palliatives and a marked increase in the use of bituminous surfaces. This tendency is due in part to the unsatisfactory results which have accrued from using bituminous materials which did not "set up" in from 24 to 48 hours, to the necessity for repeated closing of thoroughfares and to the recognition on the part of many that bituminous surfaces are more economical and efficacious in the long run that treatments with palliatives. This change is not only characteristic of state work, but is even more characteristic of municipal work where the tracking of bituminous materials results on the whole in more material damage to property.,

The second marked development under bituminous surfaces is in the increased use of various types of pressure and gravity distributors which have been specially designed for this work. The consequent abandonment of the use of pouring cans and ordinary watering carts for this work is to be commended. Many types of these machines have been used during the past year for this kind of work. It has been unfortunate that sufficient information has not been at hand covering the use of these various machines so that an engineer might know the limitations of a machine before purchasing. It is self-evident that, given the kind of bituminous material, the temperature of the material, the rate at which the distributor travels, the calibration of the distributor should be such that the operator will know how much it will distribute per square yard. Information of this character will without doubt be forthcoming with reference to many of the distributors to be used during the season of 1912. Extravagant claims have been made by the designers and manufacturers of distributors. In a certain instance it has been claimed that materials, ranging in character from light oil to an asphalt cement of a consistency suitable for use in the construction of sheet asphalt pavements, could all be distributed by a given machine in amounts per square yard varying from ⅛ gal. to 2 gal. Recently the writer's attention was called to the fact that a certain designer was recommending the use of a pressure distributor, which necessitated the use of a steam roller in its operation, for the distribution, as a surface application, of a palliative which is always applied cold.

BITUMINOUS SURFACES ON CEMENT CONCRETE—During 1911 bituminous surfaces have not only been used extensively on macadam and gravel roads, but they have also been used to a considerable degree on cement-concrete pavements. The improvement of the concrete pavement by the addition of the bituminous surface is marked, as, if the proper kind of bituminous material is used, the pavement is non-productive of dust, is not slippery, and is less noisy than the ordinary concrete pavement. There is no apparent reason why the results accruing from the use of bituminous surfaces on brick pavements would not be equally good. Especially would such be the case where bituminous fillers are used, thus combining many of the advantages of bituminous fillers and bituminous surfaces with the inherent good qualities of brick pavements.

PENETRATION METHODS—In the field of the construction of bituminous pavements by penetration methods the numerous methods which have been employed during 1911 will be described. All these methods have as the principal desiderata the keeping of the bituminous material within 2 in. of the road surface and the securing of the uniform incorporation of the bituminous material and the broken stone. Due to the lack of uniformity in the density of the surface and in the amount of bituminous material applied by the many methods employed, it is obvious that the uniform incorporation of the road metal and the bituminous cement is difficult to obtain. The average pavement has been generally built in two courses, the foundation course being about 4 in. thick after rolling and the top course about 2 in. thick after rolling. Following are brief descriptions of the various methods to which reference has been made. In all the methods the construction is completed by the application of a thin coat of sand, stone chips or screenings.

Type A: For the upper course broken stone is used containing sufficient small sized particles to materially reduce the voids, as for instance crusher-run stone which passes a 1½-in. screen and is supposed to be retained on a ½-in. screen. In this method, after the upper course is laid, the bituminous material is applied either before or after the surface is rolled, some favoring the former, because of the greater depth of penetration secured. When the upper course is rolled after the application of the bituminous material, a coat of mineral matter has usually been spread over the surface before rolling. The necessity for a second application or seal coat of bituminous material is determined by traffic conditions in many cases, although standard practice in some departments is responsible for the use of one or the other method, independent of the traffic.

Type B: In case the metal of the upper course is a uniform product of about 1 in. or 1½ in. in size, the bituminous material is applied after the course has been lightly rolled. Stone chips are then spread upon the surface and thoroughly rolled. After the surface is broomed, another coat of bituminous material is applied. The above method is also used when the road metal varies from 1½ to 2½ in., in which case ¾-in. stone is usually employed in place of chips.

Type C: The foundation courses are filled to a certain extent with sand or small sized broken stone, and after the course is rolled, excess mineral matter is swept off. After the upper course of road metal is applied, its voids are filled to within about 1 in. of the surface and the bituminous material applied. The road is finished with a coat of sand or chips which is rolled, although in some cases a second application of bituminous material and chips is used.

Type D: A closely packed foundation or a concrete base is used and large and uniform sized stone employed for the wearing course. In this method a layer of sand, ¼ in. thick, is placed on the bottom course and bituminous material distributed, using about 1 gal. per sq.yd. The upper course of metalling is applied and the upper course thoroughly rolled, the bituminous mastic tending to fill the voids of the upper course. Another coat of bituminous material is applied and the surface finished by the application of a coat of chips or two applications of bituminous material are made, using likewise two coats of sand or chips.

Type E: The upper course is constructed in the usual manner and in place of sand or stone chips, a bituminous mastic is applied to the surface, being rolled into the voids and forming the finished surface of the road.

The remarks pertaining to distributing machines mentioned in connection with the discussion on bituminous surfaces apply with equal force to types of distributors used in the construction of bituminous pavements by penetration methods.

PATENT QUESTIONS—The construction of bituminous concrete pavements in connection with which broken stone is used in the aggregate has been developed along certain lines during 1911, although

fear of litigation has restrained many engineers from advocating the use of this type of pavement. Considering the diversity of the judicial opinions which have been rendered relative to patents descriptive of various types of pavements and the extravagant claims made by some patentees, it is not surprising that some engineers and public officials believe that the following quotation applied to the use of bituminous concrete pavements: "Unto everyone which hath shall be given: and from him that hath not, even that he hath shall be taken away from him."

However, in contemplating the work which has been accomplished by the use of bituminous materials in this class of construction during 1911, it is evident that even the laity has appreciated the marked tendency to have faith that the courts of the United States, if necessity arises, will recognize that prior art and printed descriptions cover many satisfactory combinations of aggregates which, when embodied in pavements, have inherent stability.

Instances of development in this field of construction will be cited in connection with each of the types of bituminous concrete pavements to be considered later. Although it is not intended to draw up a brief, nevertheless it may be of interest to include in this résumé reference to certain specific cases of the early use of each type of aggregate. In connection with this phase of the art and science of using bituminous materials it is well to have in mind that portion of our patent laws which reads thus:

> Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof, not known or used by others in this country, before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor.

It is the opinion of expert patent lawyers that the construction of a pavement according to any description published two years prior to the date of application of the patent, which may be under consideration, could not be prevented regardless of the validity of that patent. It may be that the disclosure of the process may invalidate the patent, as it is entirely possible that in the issuing of the patent some evidence of prior art might easily have been overlooked. It might be well if the old saying, "to err is human," was always in mind when considering the validity of patents.

BITUMINOUS CONCRETE PAVEMENTS, in the aggregates of which broken stone forms an integral part, may be divided into three groups, as follows, the classification being based upon the character of the mineral aggregate:

Type A: One size crusher-run stone, that is, any one product of a crushing plant.

Type B: Combinations of one size crusher-run stone and fine mineral matter, such as sand, stone screenings and fine gravel.

Type C: Finely graded aggregates of broken stone and sand or other mineral matter.

Naturally Type A has been very popular, due to its inherent simplicity. During the year past the writer has seen excellent pavements constructed by this method where the aggregate was a one-size crusher-run stone having the following characteristics based upon a mechanical analysis: all the stone passed a 1¼-in. sieve; not over 25% passed a 1¼-in. sieve and was retained on a ¾-in. sieve; and not over 5% passed a ¼-in. sieve. Descriptions of old pavements of this type are legion. As an illustration may be cited the following specifications used in England prior to 1899:

> The hot stone, when ready for mixing, is screened into material of three sizes, 1 to 2 in. for the body, ½ to 1 in. for the intermediate coat, and ¼ to ½ in. for the top dressing. The coarsest material is used in a layer 3 to 4 in. thick, the intermediate size forms a coat of about ⅝ in., and the top dressing is used in thinnest layer possible, with a view to filling all interstices. Afterward a dressing of ¼-in. and smaller granite screenings is scattered broadcast, and the traffic at once allowed on the road to work this top dressing into the tarred material. Each of the layers is rolled separately with a 10-ton roller.

The State Board of Public Roads of Rhode Island has used Type A since 1906. It has been admitted in writing by certain patentees "that so long as the construction is of the nearly uniform sizes of stone which you are now using, and you do not get the fine material applied from the surface or into the spaces between the particles of bitumen-coated stone more than our observations indicate you are now doing, or we believe it is possible to do, we would not claim this feature of the construction to be an infringement of our patent No. 727,505." The construction referred to in the above quotation covers the construction of a wearing course of a bituminous concrete pavement under the following specification relative to the broken stone. "The bottom course shall consist of stone from 1¼ in. to 2½ in. in their longest dimension, the upper course of stone from ½ to 1¼ in. in their longest dimensions." Only the upper course stone was mixed with bituminous material. The product of the crusher which met this specification was obtained from the ordinary type of crushing plant, the broken stone usually passing a 1½-in. screen and commercially being retained upon a ¾- or ⅝-in. screen. A mechanical analysis of a typical product used in Rhode Island may be of interest and hence is given below.

Per cent. passing 10-mesh sieve...	1.0
Per cent. passing ¼-in. sieve.....	2.5
Per cent. passing ½-in. sieve.....	30.8
Per cent. passing ¾-in. sieve.....	34.2
Per cent. passing 1-in. sieve.....	23.4
Per cent. passing 1¼-in. sieve.....	8.1

As deputy engineer for the State Board of Public Roads of Rhode Island, the writer had charge of the construction and maintenance of bituminous surfaces and bituminous pavements for a number of years and hence had the opportunity to inspect on numerous occasions the first section of bituminous concrete pavement constructed in 1906 under the above specification. This section has needed no repairs although subjected to high-speed motor-car traffic of the heavy passenger type. Without doubt broad minded judges would admit that this type of pavement has inherent stability.

The second type, that is, one having an aggregate composed of one-size crusher-run stone mixed with fine material such as sand, screenings or material of a similar character, is likewise described many times in early technical literature. For example, the following description was published over thirty years ago:

> The manner of preparing, treating and laying the asphalt mass is as follows: He took asphalt, 125 parts; petroleum oil, 25 parts. These substances were melted and thoroughly incorporated together, and to this mixture he added in a heated state, sand or powdered stone, 750 parts, and gravel or broken stone, also heated, 1100 parts. The whole was then thoroughly mixed.

During 1911, Type B was popular in various quarters. In Washington, D. C., under the jurisdiction of Captain Mark Brooke, of the Office of the Engineer-Commissioner, bituminous concrete pavements were constructed under the following specifications covering mineral aggregate: "The paving materials shall be composed of crushed trap-rock screenings, concrete sand and mineral dust in the following proportions: Trap-rock screenings, two parts; concrete sand, one part, and mineral dust, at least 5% of the above aggregate; mixed with asphaltic cement." The trap-rock screenings referred to above varied in size from 1 in. to screenings and were devoid of dust. Detailed specifications were also given with reference to the character of the sand and the mineral dust. The writer has had the good fortune to examine various streets paved under the above specifications. In his humble opinion these pavements possess inherent stability under commercial traffic.

In connection with the discussion of the use of the third type, that is, a graded aggregate of broken stone with or without sand and fine mineral matter, the consideration of the following description, so old as to be covered with the dust of decades, is apparently pertinent:

> Broken stones are preferred for the whole pavement, and shall alone be used for the covering. The greatest dimension of stones for the base (except as hereinafter noted) shall be between 3 in. and ¼ in., and for the covering, between 2 in. and $\frac{1}{10}$ of an in.; the sizes shall be mixed in proportion, varying with the size to form a close mass, which, when dry and compact, can absorb not more than 20% of water.

During 1911 many thousands of yards of a pavement of Type C have been laid. In the Borough of Richmond, New York City, over 40,000 sq.yd. were laid on a total of 18 streets last year under direction of Theodor S. Oxholm. The mineral aggregate used conformed to the now famous Topeka specifications. A decree was signed by certain officials and representatives of certain patentees covering the use of the Topeka mineral aggregate. The following quotation is from the decree to which reference has been made:

> It appearing to the court that of the mineral matter used in the pavements actually constructed in the cities of Topeka and Emporia, Kan., no particles of stone were used that would not pass a screen with openings ½ in. in diameter, and that less than 10% of the stone or coarse sand used would be retained upon a screen with openings ¼-in. in diameter, and the remaining mineral matter used being finer than ¼ in.; and it further appearing that pavements constructed by the use of mineral particles as above described do not infringe the claims of complainant's patent No. 727,505, sued upon in this case. And it further appearing that the pavements as actually constructed in the cities of Topeka and Emporia, Kan., do not infringe the claims of complainant's patent No. 727,505, sued upon in this case, and that any pavement hereafter constructed in substantial compliance with the following formula, to wit:

	Per cent.
Bitumen	7 to 11
Mineral aggregate, passing 200-mesh screen	5 to 11
Mineral aggregate, passing 40-mesh screen	18 to 30
Mineral aggregate, passing 10-mesh screen	25 to 55
Mineral aggregate, passing 4-mesh screen	8 to 22
Mineral aggregate, passing 2-mesh screen	less than 10

> sieves to be used in the order named would not infringe the claims of said patent.

MIXING MACHINES—Mention should be made of the effect of the introduction of various types of low priced mixing machines during 1911. The economical and satisfactory results accruing from the use of these machines for mixing certain types of aggregates with bituminous cements has caused the introduction of the mixing method in many localities where only the penetration method has formerly been used. During the season of 1912 many new machines of this type will be used with the consequent increase in the construction of the various types of bituminous concrete pavements outlined above.

SHEET ASPHALT—During 1911 considerable thought has been devoted to the methods and materials employed in the construction of sheet asphalt pavements. Notable work has been done by a Special Committee of the American Society for Municipal Improvements and the Committee of the Association for Standardizing Paving Specifications. Throughout the United States there appears to be crystallizing a firm belief that specifications for materials should be opened to admit such asphalt cements as "Bermudez," "California," "Pioneer," "Texaco" and "Trinidad," for instance, which have shown by service tests that excellent pavements may be constructed by their use. This tendency is commendable as thus competition is increased and the high quality of the asphalt cement is maintained.

A New Type of Centrifugal Pump for Low Heads at Steam Turbine Speeds

BY CHARLES A. CARPENTER*

Centrifugal pumps driven directly by steam turbines have not been hitherto available for low-head service, because for low heads the pumps must be run at a speed too low for the best turbine economy. A type of pump capable of running efficiently with low head at much higher speed than other designs has been recently developed by C. V. Kerr, Chief Engineer of McEwen Bros., of Wellsville, N. Y., who is best known perhaps for his invention of the Kerr steam turbine.

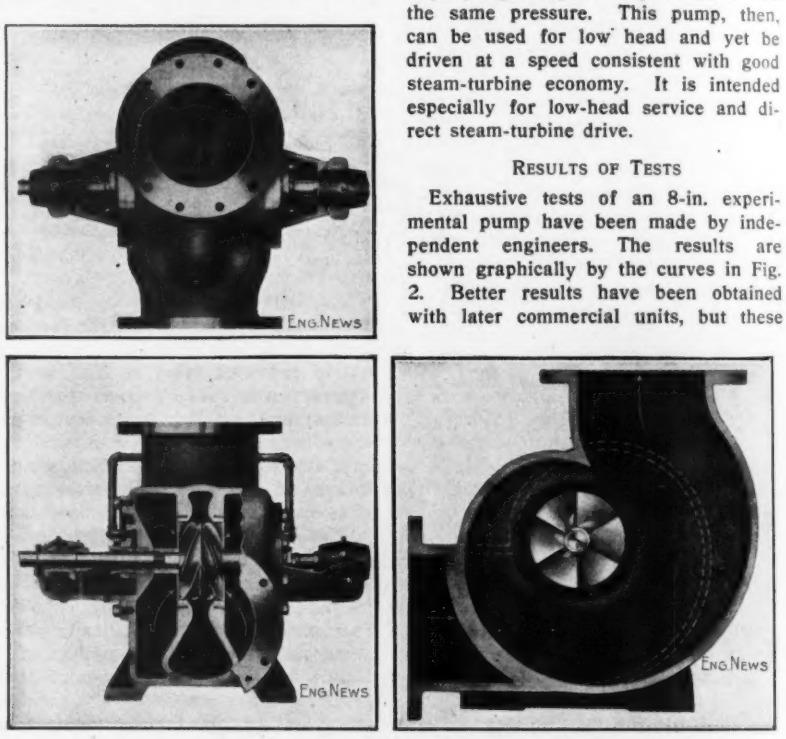

FIG. 1. PLAN AND SECTIONAL ELEVATIONS OF THE KERR CENTRIFUGAL PUMP
(McEwen Bros., Wellsville, N. Y., builders.)

The runner of this pump has helicoidal vanes not unlike the blades of a screw propeller or an electric fan. Its action can be understood from the sectional views in Fig. 1. The main body of the runner, from which the vanes project radially, is shaped like the frustum of a cone so that the water is deflected during its passage through the runner from an axial direction and discharged from the periphery at a small angle to a tangent.

As shown in Fig. 1, the pump is constructed with a double helical runner having two parts with opposed spirals. The larger bases of the conical bodies are placed together so that water enters the runner axially from both sides and is discharged at the juncture of the two halves. The water is discharged into a volute casing similar to that used with other centrifugal pumps.

The advantages claimed for this pump depend on its large area of inlet opening. It is evident from Fig. 1 that water can be taken in all across the runner from the hub to the outside diameter. This means, comparing it with an ordinary centrifugal of the same capacity, less diameter for equal inlet velocity; and consequently, even with similar vane angles, higher speed may be used with the same pressure. This pump, then, can be used for low head and yet be driven at a speed consistent with good steam-turbine economy. It is intended especially for low-head service and direct steam-turbine drive.

RESULTS OF TESTS

Exhaustive tests of an 8-in. experimental pump have been made by independent engineers. The results are shown graphically by the curves in Fig. 2. Better results have been obtained with later commercial units, but these curves show the general characteristics of the design.

It will be noted that maximum pressure occurs at no discharge. This is the best condition for convenience in starting a pump, as no overspeeding or bleeder system is needed to meet such difficulties as are common in pumps normally operated at higher head than the cutoff pressure. Another interesting feature is the gradual slope of the capacity-head curve, in connection with the very flat efficiency curve. These two features insure economical operation over a wide variation in demand.

*Manager, New York Sales Office, McEwen Bros., 149 Broadway, New York.

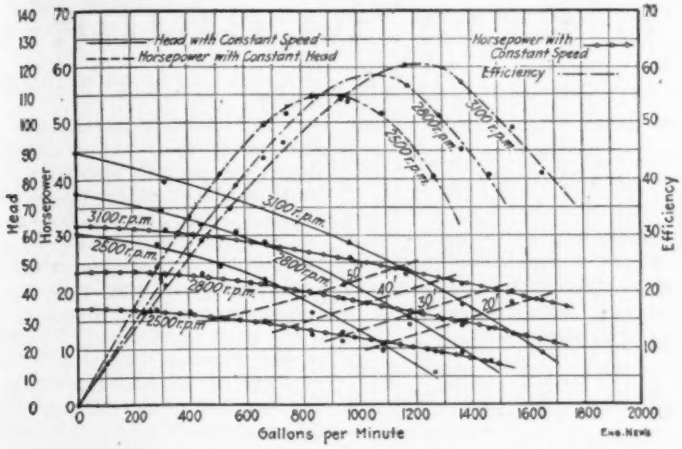

FIG. 2. CURVES SHOWING RESULTS OF TESTS OF AN 8-IN. KERR PUMP

The curves showing the horsepower required at 50-, 40-, 30- and 20-ft. heads for different speeds and quantities show how nearly the brake horsepower is proportional to quantity. Centrifugal pumps of the ordinary type have been condemned for some uses because of the lack of this property. These brake horsepower curves are interesting furthermore in that they show the power steadily decreasing with the pressure. With fixed pressure, the horsepower at low discharge is not over 40% of that at full rated capacity, due to the low speed needed to maintain the pressure. Then as the discharge valve is opened, the revolutions of the pump increase up to the normal speed. The pump thus automatically adjusts itself to the right speed to produce adequate pressure. The quantity increases greatly with slightly less pressure, and dangerous speeds cannot be produced for the reason that the turbine is overloaded before such a speed can be reached.

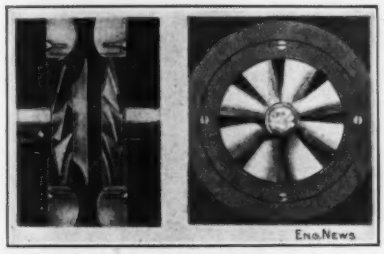

FIG. 3. PROPELLER TYPE OF RUNNER FOR KERR PUMP
(Used for the lowest heads.)

CONSTRUCTION DETAILS

The inside of the pump is readily accessible by removing the outer bearing head. When this has been done, the mechanic can withdraw all the running parts axially. This operation is facilitated by the comparatively small diameter of the runner. The shaft is entirely protected from the action of the water by the impeller itself and by removable bronze bushings which project through the casing, preventing the scoring of the shaft by tight packing. Both soft packing and a water seal are provided. The bearings are of the ring-oiling type. Thrust collars are provided to take any possible end thrust, although the runner is hydraulically balanced. The casing around the periphery of the impeller is protected from erosion by removable bronze wearing rings.

The pumps are built for capacities of from 1000 to 50,000 gal. per minute, and for heads up to 75 ft. Suction lifts up to 25 ft. are easily cared for. The larger pumps are intended for condenser circulating pumps and for irrigation, drainage, prefiltration service, etc. When it is desired to maintain steam-turbine speed at heads as low as 5 to 20 ft., the helical blades of the standard impeller are replaced by blades of the propeller type, which are really helical blades cut short and given an increased pitch to suit the head required. An impeller of this type is shown in Fig. 3. The two types of impellers are interchangeable in the same casing. A line of hotwell pumps, ranging in size from 3 in. to 6 in. diameter for capacities from 100 to 900 gal. per minute, has also been developed. These pumps have an unusual ability to handle mixtures of air and water.

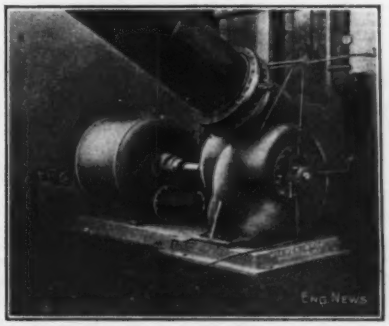

FIG. 4. A 30-IN. KERR PUMP AS ARRANGED FOR TESTING
(Built for the New York Edison Co. Capacity, 30,000 gal. per min.; weight, 7000 lb.; floor space, 75x85 in.)

A 30-in. pump of 30,000 gal. per minute capacity, built for the New York Edison Co., is shown in Fig. 4. A 30-in. pump of one design delivers 19,000 to 26,000 gal. per minute at 1500 r.p.m. and runs economically at heads of 110 to 60 ft., absorbing 880 to 660 hp. A 3-in. pump at 3600 r.p.m. delivers 125 to 160 gal. per minute at heads of 50 to 60 ft., absorbing between 4 and 5 hp. Its weight is about 300 lb.

The range of capacity and head given above is only general. The design of each pump is varied to suit the conditions under which it must work, and particularly good results are obtained where low pressures are necessary.

A 20-in. pump, with its casing entirely of bronze, has been recently built for the Westchester Lighting Co., to supply cooling water for a Curtis turbo-generator set at the New Rochelle, N. Y., station. The water pumped is salty with some sewage content. The cost for the bronze pump was about 60% more than for the usual type with cast-iron casing.

Owing to the shallow water in the bay from which the pump takes suction, there is considerable temperature change, and the pump had to be designed for good economy, over a wide capacity range. In use, the unit delivered from 6000 to 12,000 gal. per min., depending on the speed and on the temperature of the water.

Typhoid Pollution of Wells—A paper with the foregoing title, read by Dr. H. W. Hill, Epidemiologist of the Minnesota State Board of Health, before a recent meeting of the Illinois Water Supply Association, concluded as follows:

(1) The idea that typhoid fever is exclusively a water disease is wholly mistaken. In Minnesota not more than one-third of the cases so originate. Two-thirds are due to carriage of infection directly from patients and their discharges by hands, flies, etc., which infect eating utensils, food, milk, etc.

(2) The idea that any great percentage even of the water typhoid is due to infected wells is also a great mistake—at least in Minnesota. Drilled and driven wells are, practically speaking, not capable of infection, through the soil, and seldom from the surface. Dug wells in sand or clay soils receive pollution chiefly from surface wash. Water typhoid usually (in Minnesota) is the result of drinking infected surface waters.

(3) No well should be continued in use if unfiltered human discharges have access to it; not because typhoid fever will necessarily develop therefrom, but because, if unfiltered human discharges reach a well at all, there is always a chance that infected human discharges containing typhoid bacilli will one day take the same route and infect the same water.

(4) When a case of typhoid fever occurs, study the history of the patient to discover where he was and what he ate and drank and with whom he came in contact during the second and third weeks preceding his date of earliest symptoms. These will be the third and fourth weeks preceding the date of his going to bed, as a rule.

(5) Don't make the illogical mistake of attributing a single case of typhoid to the use of a well, which many other persons were using at the date of his infection without ill effects, which is not subject to surface contamination and is sunk in clay or sand.

Concrete Column Economics

By J. Norman Jensen *

The author has investigated the cost of different types of reinforced-concrete columns under typical loads and with the usual variations of reinforcement and quality of concrete. He comes to the conclusion that cement is the best reinforcement.

*Architectural Engineer, Dept. of Bldgs., City of Chicago.

In order to test the truth of the frequently quoted statement that "the cheapest reinforcement is cement," the writer has designed a number of different types of reinforced-concrete columns under typical conditions of load and has made detailed comparisons of their cost.

All columns were designed in conformity with the present Building Ordinance of the city of Chicago. The sections of this ordinance relating to reinforced-concrete columns are as follows:

Ratio of Moduli of Elasticity—Adhesion—Bond. The calculations for the strength of reinforced concrete shall be based on the assumed ultimate compressive strength per square inch designated by the letter "U" given in the table below for the mixture to be used.

The ratio designated by the letter "R" of the modulus of elasticity of steel to that of the different grades of concrete shall be taken in accordance with the following table:

Mixture	U	R
1 cement, 1 sand, 2 broken stone, gravel or slag.....	2,900	10
1 cement, 1½ sand, 3 broken stone, gravel or slag.....	2,400	12
1 cement 2 sand, 4 broken stone, gravel or slag.....	2,000	15

The compressive stress in steel shall not exceed the product of the compressive stress in the concrete multiplied by the elastic modulus of the steel and divided by the elastic modulus of the concrete.

Direct compression in concrete shall be one-fifth of its ultimate strength.

All reinforcing steel shall be accurately located in the forms and secured against displacement, and inspected by the representative of the architect or engineer in charge before any surrounding concrete be put in place. It shall be afterwards completely inclosed by the concrete, and such steel shall nowhere be nearer the surface of the concrete than 1½ in. for columns.

Reinforced Concrete Columns—Limit of Length—Per Cent. of Reinforcement—Bending Moment in Columns—Tying Vertical Rods. (a) Reinforced concrete may be used for columns in which the concrete shall not be leaner than a 1: 2: 4 mixture, and in which the ratio of length to least side or diameter does not exceed 12, but in no case shall the cross-section of the column be less than 64 sq.in. Longitudinal reinforcing rods must be tied together to effectively resist outward flexure at intervals of not more than 12 times least diameter of rod and not more than 18 in. When compression rods are not required, reinforcing rods shall be used, equivalent to not less than ½% of the cross-sectional area of the column; provided, however, that the total sectional area of the reinforcing steel shall not be less than 1 sq.in., and that no rod or bar be of smaller diameter or least dimensions than ½ in. The area of reinforcing compression rods shall be limited to 3% of cross-sectional area of the column. Vertical reinforcing rods shall extend upward or downward into the column, above or below, lapping the reinforcement above or below enough to develop the stress in rod by the allowable unit for adhesion. When beams or girders are made monolithic with or rigidly attached to reinforced-concrete columns, the latter shall be designed to resist a bending moment equal to the greatest possible unbalanced moment in the beams or girders at the columns, in addition to the direct loads for which the columns are designed.

When the reinforcement consists of vertical bars and spiral hooping, the concrete may be stressed to one-fourth of its ultimate strength, provided, that the amount of vertical reinforcement be not less than the amount of the spiral reinforcement, nor greater than 8% of the area within the hooping; that the percentage of spiral hooping be not less than ½% nor greater than 1½%; that the pitch of the spiral hooping be uniform and not greater than one-tenth of the diameter of the column, nor greater than 3 in.; that the spiral be secured to the verticals at every intersection in such a manner as to insure the maintaining of its form and position, that the verticals be spaced so that their distance apart, measured on the circumference be not greater than 9 in., nor one-eighth the circumference of the column within the hooping. In such columns, the action of the hooping may be assumed to increase the resistance of the concrete equivalent to 2½ times the amount of the spiral hooping figured as vertical reinforcement. No part of the concrete outside of the hooping shall be considered as a part of the effective column section.

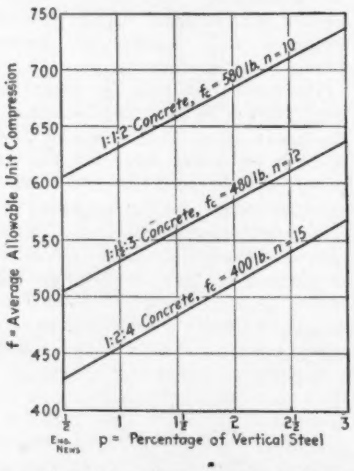

FIG. 1. VERTICALLY REINFORCED-CONCRETE COLUMNS. GRAPHS OF THE FORMULA $f = f_c [1 + (n - 1) p]$

It will be noticed that the ratio of the modulus of steel to that of concrete varies with the richness of the mix. It seems to the writer that this is the logical way, instead of using the same value for all mixes, as is sometimes done. The requirements in regard to materials and workmanship are such as to insure the best grade of concrete structures.

In the computations of these columns certain formulas were used. The first of these is for what the writer calls "reinforced-concrete columns," that is, for columns reinforced with vertical steel only, tied in a suitable manner. This formula is the same as found in standard textbooks on reinforced concrete. Its derivation is only repeated for the sake of clearness, and to bring out the derivation of the formula for hooped columns. By "hooped columns" is meant columns reinforced with vertical steel and with spiral hooping also.

NOTATION

It was necessary in the derivation of these formulas to adopt the following notation:

f = Average allowable unit compression upon the effective cross-section of the column.

f_c = Allowable unit compression upon the concrete of the column.

f'_s = Allowable unit compression upon the vertical steel in the column.

$n = \frac{E_s}{E_c}$ = Ratio of modulus of elasticity of steel to modulus of elasticity of concrete.

P = Load to be carried by the column.

A = Area of total effective cross-section of column = area out to out of hooping in hooped column = gross section-area required for fireproofing of reinforced-concrete column.

A_c = Area of concrete in cross-section.

A_s = Area of vertical steel in cross-section.

A_h = Area of hooping steel in cross-section.

$p = \frac{A_s}{A}$ = Ratio of cross-section of vertical steel to effective cross-section of column.

$\frac{A_h}{A} = p'$ = Ratio of cross-section of hooping steel to effective cross-section of column.

FORMULAS

Below is given the derivation of the various formulas.

REINFORCED-CONCRETE COLUMNS—The ordinance states that the compressive stress in vertical steel shall not exceed $f_c n$. Therefore $f'_s = n f_c$.

Total load carried by steel

$$= f'_s A_s = n f_c A_s$$

Total load carried by concrete

$$= f_c A_c$$

Total load carried by column

$$= P = n f_c A_s + f_c A_c$$

$$P = fA$$

and

$$A_c = A - A_s$$

therefore

$$fA = n f_c A_s + f_c (A - A_s)$$

$$f = f_c \left[\frac{n A_s}{A} + \left(1 - \frac{A_s}{A} \right) \right]$$

but

$$\frac{A_s}{A} = p$$

therefore

$$f = f_c [np + (1 - p)] = f_c [1 + (n - 1) p] \quad (1)$$

HOOPED COLUMNS—The ordinance states "the action of the hooping may be assumed to increase the resistance of the concrete equivalent to two and one-half times the amount of the spiral hooping figured as vertical reinforcement."

Total load carried by hooping

$$= 2.5 f_s A_h = 2.5 n f_c A_h$$

"Increased resistance of concrete"

$$= \frac{2.5 n f_c A_h}{A} = 2.5 n f_c p'$$

Total allowable resistance of concrete

$$= f_c + 2.5 n f_c p' = f_c (1 + 2.5 n p')$$

Total load carried by concrete

$$= f_c (1 + 2.5 n p') A_c$$

Total load carried by steel

$$= f_s A_s = f_c (1 + 2.5 n p') n A_s$$

Total load carried by hooped column

$$= fA = f_c (1 + 2.5 n p') (A_c + n A_s)$$

But

$$A_c = (A - A_s - A_h)$$

therefore

$$fA = f_c (1 + 2.5 n p')(A - A_s - A_h + n A_s)$$

$$= f_c (1 + 2.5 n p') [A - A_h + (n - 1) A_s]$$

But

$$\frac{A_h}{A} = p'$$

and

$$\frac{A_s}{A} = p$$

therefore

$$f = f_c (1 + 2.5 n p') \left[1 - \frac{A_h}{A} + (n - 1) \frac{A_s}{A} \right]$$

$$= f_c (1 + 2.5 n p') [1 - p' + (n - 1) p] \quad (2)$$

The formulas thus derived are too unwieldy for ordinary use. In order to facilitate the computations of the columns, these formulas were plotted on four separate diagrams. Diagram No. 1 (Fig. 1) shows the relation between the percentage of vertical steel in a reinforced-concrete column of the concrete mixes shown, and the average allowable compression. Diagrams Nos. 2, 3 and 4 (Figs. 2, 3 and 4) show the relation between the percentage of vertical steel and the average allowable unit compression with the percentage of spiral reinforcement and the mix known. The extremities of each diagram represent the minimum and maximum percentages of vertical steel allowed by the ordinance, and the top and bottom curves represent the maximum and minimum percentages of spiral reinforcement allowed.

It will be seen by a study of these curves that some of the values for the average allowable unit compression run extremely high. A comparison of some of these values and of laboratory tests in which the mix, the percentage of vertical steel, and of spiral steel are identical discloses the fact that the factor of safety based on the yield point of the column is about 2.5. For all practical purposes this yield point represents the ultimate strength of the column, as the resulting deformation after the yield point is passed is so great that the reinforced-concrete structure would be badly cracked if not wrecked if this deformation ever occurred.

Wishing to satisfy himself as to this question of economical design, the writer designed a column shaft. A panel 20 x 20 ft. was taken. The building was assumed to be eight stories high, and the column designed for a roof load of 25 lb. per sq.ft. and a floor load of 100 lb. per sq.ft. In carrying down the live load on the floors, 85% was taken on the top floor and a reduction of 5% of the live load taken for each floor until 50% was reached, when no further reduction was made. It was assumed that the floors of this building could not all be loaded with the full live load at once, and that such a reduction was permissible according to the ordinance. A typical section of the panel and a column schedule is given in Fig. 5. The dead load given includes the weight of the construction, the weight of the granitoid finish, and an allowance for partitions.

In the original study an investigation was made of the columns on the seventh, fifth, third and first floors, thus insuring a range of total loads sufficiently great so that an idea could be obtained of the relative economy for various loads. On account of lack of space it is impossible to present all of these figures here, but it is thought that the accompanying Tables I-IV will be sufficient to demonstrate the extent of the investigation. Table I shows the complete analysis of the vertically-reinforced-concrete column for the fifth story, under a load of 285,000 lb. Table II shows the complete analysis of the same column for the hooped column,

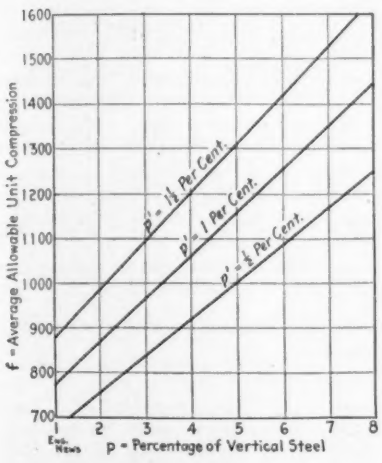

FIG 2. 1:2:4 CONCRETE. $n = 15$, $f_c = 500$

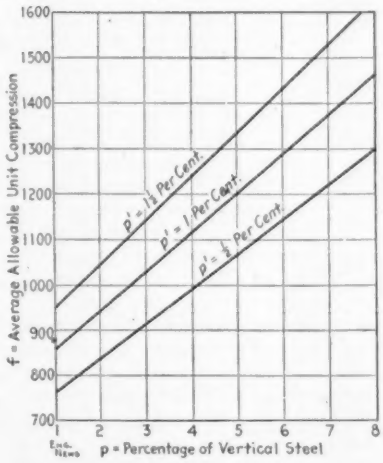

FIG. 3. 1:1½:3 CONCRETE. $n = 12$, $f_c = 600$

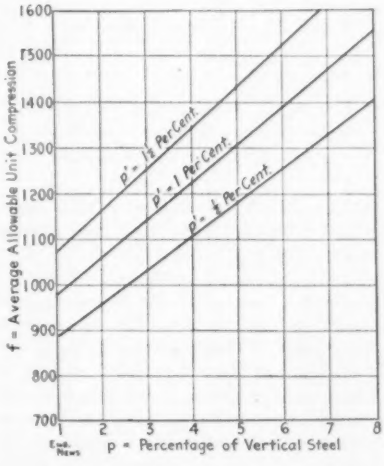

FIG. 4. 1:1:2 CONCRETE. $n = 10$, $f_c = 725$

FIGS. 2-4. HOOPED REINFORCED-CONCRETE COLUMNS

GRAPHS OF THE FORMULA: $f = f_c [1 + 2.5 np'] [1 - p' + (n - 1) p]$

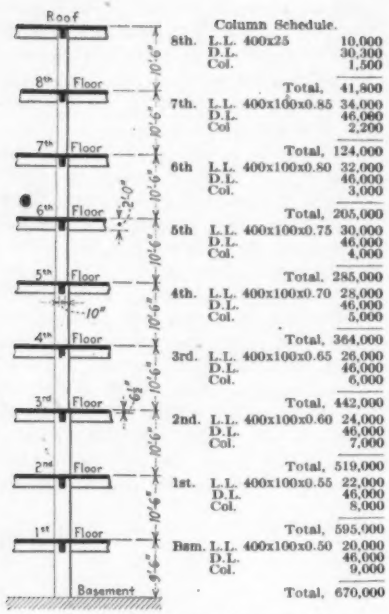

FIG. 5. OUTLINE OF COLUMN SHAFT ANALYZED FOR COSTS OF COMPARATIVE TYPES OF COLUMN

with ½% of spiraling. For both types three different percentages of vertical reinforcing and three different mixtures of concrete were investigated. Table III gives the results of the computation's shown in Table I for the four separate loads under investigation and Table IV the results of the computations shown in Table II for the same loads. Each of the figures given in Tables III and IV were computed in the manner outlined in Tables I and II and described in detail below.

METHOD OF DESIGN AND EXPLANATION OF TABLES

In the design of hooped columns the following method was used. Knowing the total load, a concrete mixture, percentage of spiral steel p', and percentage of vertical steel p was assumed. With the aid of Diagrams 1, 2, 3 and 4 an average allowable unit compression f was obtained from the left of the diagram. The "Total Load" P (Fig. 5) was divided by this value of f, thus obtaining the "Area of Core" A (Table II). The "Area of Vertical Steel" A_s represents the product of A and p. Knowing A the "Dia. of Core" D was obtained from tables, to the nearest inch. The "Size of Col." represents the side of a square column, or the short diameter of an octagonal column, or the diameter of a round column. It was obtained by adding 3 in. to the diameter of the core, as the ordinance requires 1½ in. fireproofing of the core.

The ordinance states that "The spiral hooping shall be figured as vertical reinforcement." In order to obtain the "Dia. & Pitch of Spiral," it was necessary to use the following formula:

Let

s = Pitch of spiral in inches,

D = Diameter of core of spiral in inches,

a = Area of cross-section of spiral,

Then

$$A_h = \frac{3.14\, a\, D}{s}$$

A_h equals the product of A and p'. Assuming a and knowing D and A_h, the pitch was figured from the above formula. If the pitch of the spiral became greater than that allowed by the ordinance, a smaller diameter spiral was used. The pitch is given to the nearest ⅛ in., as the mills that fabricate spirals can manufacture them to such a pitch.

In computing the "Wt. of Vert. Steel," the bars were assumed long enough to lap 30 diameters, and the weight obtained on this basis. The "Wt. of Spiral Steel" was obtained by multiplying A_h by 3.4, and also by the length of the column. The weight of the spacers used in this type of reinforcement is not included, but an allowance made for it in the unit price used.

The "Cu. Ft. Conc." for square, octagon, and round columns includes the concrete from the floor line to the under side of the slab above.

An item which does not appear in the table is that of formwork. This formwork is measured by the square feet of surface in contact with the column. Thus a 24-in. square column, 10 ft. high, would have 4 × 2 × 10 = 80 sq.ft. of formwork per column.

The "Total Cost" was obtained by adding together the different items of vertical steel, spiral steel, concrete, and formwork for the column in question.

Reinforced-concrete columns were designed in the same general way. Ties, ¼ in. round, 12 in. c. to c., were used

TABLE I. ANALYSIS OF COST OF VERTICALLY REINFORCED-CONCRETE SQUARE COLUMNS, UNDER LOAD OF 285,000 LB.

Description	1:2:4 Concrete, Vertical Steel 1%	2%	3%	1:1½:3 Concrete, Vertical Steel 1%	2%	3%	1:1:2 Concrete, Vertical Steel 1%	2%	3%
Area of core	625	556	502	535	488	447	450	417	387
Area of vert. steel	6.25	11.12	15.06	5.35	9.76	13.41	4.50	8.34	11.61
Size of sq. col.	28″	27″	26″	25″	25″	24″	24″	24″	23″
Wt. of vert. steel	274	503	658	233	421	594	210	368	503
Wt. of ties	16	15	15	15	14	14	14	14	13
Cu.ft. of concrete	54.5	50.8	47.0	47.0	43.5	40.0	40.0	40.0	36.8
Total cost	27.99	33.22	36.40	25.63	29.61	33.29	23.94	28.26	30.85

TABLE II. ANALYSIS OF COST OF SPIRALLY HOOPED REINFORCED-CONCRETE COLUMNS UNDER LOAD OF 285,000 LB. AND WITH ¼% SPIRALS

Description	1:2:4 Concrete, Vertical Steel 2%	4%	6%	1:1½:3 Concrete, Vertical steel 2%	4%	6%	1:1:2 Concrete, Vertical steel 2%	4%	6%
Area of core	376	308	262	340	288	250	298	258	228
Area of vert. steel	7.52	12.32	15.72	6.80	11.52	15.00	5.96	10.32	13.68
Dia. of core	22″	20″	19″	21″	19″	18″	20″	18″	17″
Size of col.	25″	23″	22″	24″	22″	21″	23″	21″	20″
Dia. and pitch of spiral	½″-1½″	½″-2″	½″-2½″	½″-1½″	½″-2″	½″-2½″	½″-2″	½″-2″	½″-2″
Wt. of vert. steel	342	548	684	280	499	658	263	447	605
Wt. of spiral steel	69	55	47	62	52	44	55	50	47
Cu.ft. conc. sq. col.	43.5	36.8	33.6	40.0	33.6	30.7	36.8	30.7	27.8
Cu.ft. conc. oct. col.	36.0	30.5	27.8	33.1	27.8	25.4	30.5	25.4	23.0
Cu.ft. conc. round col.	34.1	28.9	26.4	31.4	26.4	24.1	28.8	24.1	21.8
Total cost sq. col.	28.78	31.93	34.30	26.83	30.10	33.22	25.92	28.58	31.75
Total cost oct. col.	28.35	31.67	34.14	26.30	29.82	32.96	25.37	28.15	31.35
Total cost round col.	30.54	33.54	36.09	28.35	31.73	34.76	27.13	29.92	33.18

TABLE III. COMPARATIVE COST IN DOLLARS OF VERTICALLY REINFORCED-CONCRETE SQUARE COLUMNS UNDER FOUR DIFFERENT LOADS

Total loads, lb.		1:2:4 Concrete, Vertical steel 1%	2%	3%	1:1½-3 Concrete, Vertical steel 1%	2%	3%	1:1:2 Concrete, Vertical steel 1%	2%	3%
124,000	Side of sq. col., in.	20	19	18	19	18	17	17	17	16
	Cost in $	15.67	17.35	18.59	14.66	16.15	18.08	13.94	15.79	16.71
285,000	Side of sq. col., in.	28	27	26	26	25	24	24	24	23
	Cost in $	27.99	33.22	36.40	25.63	29.61	33.29	23.94	28.26	30.85
442,000	Side of sq. col., in.	34	33	31	32	31	29	30	29	28
	Cost in $	40.13	48.02	53.39	37.47	44.08	48.99	34.73	40.77	45.64
595,000	Side of sq. col., in.	39	37	36	37	35	34	34	33	32
	Cost in $	51.58	62.11	71.90	48.15	58.01	65.99	43.88	53.46	60.63

TABLE IV. COMPARATIVE COST IN DOLLARS OF SPIRALLY HOOPED COLUMNS

Under Load of 285,000 Lb.

[Variation of Concrete Mix, Vertical Steel and Spiralling.]

Vertical Steel		1:2:4 Concrete 2%	4%	6%	1:1½:3 Concrete 2%	4%	6%	1:1:2 Concrete 2%	4%	6%
¼% Spiral	Square	28.78	31.93	34.30	26.83	30.10	33.22	25.92	28.58	31.75
	Octagon	28.35	31.62	34.14	26.30	29.82	32.96	25.37	28.15	31.35
	Round	30.54	33.54	36.09	28.35	31.73	34.76	27.13	29.92	33.18
1% Spiral	Square	28.15	30.58	31.70	27.02	29.42	31.55	25.78	27.92	30.28
	Octagon	27.75	30.42	31.52	26.64	29.16	31.29	25.32	27.50	30.11
	Round	29.86	32.37	33.42	28.48	30.96	33.15	27.20	29.34	31.71
1½% Spiral	Square	26.84	29.40	29.64	26.57	28.53	30.13	25.58	28.15	30.23
	Octagon	26.68	29.24	29.68	26.30	28.26	30.10	25.13	27.75	30.08
	Round	28.62	31.06	31.34	28.21	30.12	31.72	26.88	29.57	31.66

throughout. The weight and cost of these ties are included in Table I.

The question may be asked why it is necessary to obtain the total cost of square, octagon and round columns. It would seem that the round column ought to be the cheapest since it has the least amount of concrete in it. In all three columns the vertical and spiral steel is the same. But this element of formwork greatly affects the cost, as will be shown later.

Discussion of Costs

The analysis of the cost of a steel column is an easy matter compared with that of a reinforced-concrete column. In the latter column four variables, vertical steel, spiral steel, concrete and formwork must all be accounted for in the total cost.

Vertical steel was figured at $1.35, base, f.o.b. Pittsburg in carload lots, with an 18c. freight rate to Chicago. The above is the price per 100 lb. The cost of unloading from the cars, hauling to the job, bending, and placing has been estimated so that the cost in place can be placed at 2¼c. per lb. Spiral steel has been estimated at $60 per ton, f.o.b. Chicago, and its cost in place figured at 4c. per lb. This cost includes the placing of spacers, and the tying of the vertical steel to the spirals. The cost of material, bending, and placing of the ties used in the reinforced-concrete columns has been estimated at 4c. per lb. It is assumed that the steel can be handled by laborers.

Cement has been estimated at $1.25 per bbl., sand $1 per cu.yd., crushed stone $1.65 per cu.yd., all f.o.b. the job. The cost of mixing, placing, incidental expenses of mixing and hoisting plant, has been estimated at $1.60 per cu.yd. of concrete.

Since the labor of mixing and placing a lean mixture of concrete is the same as a rich concrete, it follows that the only difference is in the cost of the materials. On the assumption that laborers can be obtained at 37½c. per hour, the cost per cubic foot in place of the three mixtures has been placed as follows:

1:2:4 concrete	21c.
1:1½:3 concrete	23c.
1:1:2 concrete	26c.

In the estimating of formwork a square column has been taken as a standard. It is assumed that yellow pine will be used in the forms, the price per thousand being taken at $22. The wages of form carpenters has been taken at 60c. per hour. The cost per lineal foot of an octagonal column has been estimated at 15% more than a square column of the same size, while that of a round column 50% more than a square column of the same width. The costs given include the cost of the lumber used, the labor of erecting, the labor of wrecking, the labor of ripping to a smaller size, and the labor of erecting and wrecking again. It is assumed that each floor is typical. With the above information in mind the cost per square foot of surface has been estimated as follows:

Square column, below 18 in.	10c.
Square column, 18 to 36 in.	9c.
Octagon column, 18 to 36 in.	12½c.
Round column, 18 to 36 in.	17c.

Perhaps the clearest way to show how these total costs were obtained is to carry the analysis of one column through. Assume a 1:2:4 mixture with ½% spiral steel and 4% vertical steel. Assume total load of 285,000 lb. Table II shows that the size of the octagon column required is 23 in. For a column 10 ft. high the square feet of formwork is $10 \times 0.276 \times 23 = 63.5$ sq.ft. The other quantities as to steel and concrete will be found in the table. The items of cost will therefore appear as follows:

Vertical steel, 548 lb. at 2¾c.	$15.07
Spiral steel 55 lb. at 4c.	2.20
Concrete, 30.5 cu.ft. at 21c.	6.41
Forms, 63.5 sq.ft. at 12½c.	7.94
Total	$31.62

Conclusion

It is realized that the unit prices in different localities may be different from those given by the writer. For this reason the quantities for each column are given so that a comparison may be made. With the information available the following conclusions were arrived at.

Taking up the columns reinforced with vertical steel only, it will be noticed that for the same load and the same mix the addition of vertical steel in every case is decidedly uneconomical. For the same load and the same percentage of vertical steel, the cheapest column is that which employs the richest mix. In every case the cheapest column for any load is that which has the least amount of vertical steel and the richest mix.

The same general remarks as to vertical steel and of richness of mix applies in the case of hooped columns when the percentage of spiral reinforcement is the same. For the same load, the same mix, the same percentage of vertical steel, but of different percentage of spiral steel, the column with the lowest percentage of spiral steel is the cheapest. Comparing the cost of square, octagon and round columns of the same load, the same mix, and the same percentages of vertical and spiral steel, the octagon column is the cheapest. This octagon column has the further advantage that it looks considerably smaller than a square column, and almost as small as a round column of the same diameter. For the heaviest load the cheapest hooped column is an octagon column of the richest mix and the lowest percentage of vertical and spiral steel.

Comparing the column with vertical steel only with the hooped column it will be seen that for the same load the most economical hooped column is always more expensive than the most economical reinforced-concrete column. Taking the series as a whole it is evident that "the cheapest reinforcement is cement."

The only excuse for a high percentage of steel is to obtain a high value for the average allowable unit compression, thereby insuring a small column, especially in the lower floors. In some cases so much vertical steel is used that the concrete is placed with extreme difficulty. So insistent is the demand for a small column that the careful conservative designer is forced to the realization that the reinforced-concrete column is not the solution for a heavily loaded compression member. There is a solution, but it is found elsewhere.

A Storm Sewerage System for Los Angeles, Calif., has been reported on by Homer Hamlin, city engineer, and J. W. Johnson, chief deputy engineer. The estimated cost of the system is $9,300,000, but of course it is not proposed to build the entire system at once. The report was submitted to the Board of Public Works on May 11, which approved the plan and referred the report to the City Council, with the recommendation that the sewers, when built, should be paid for by 10-year instalments through district assessments for benefits.

Accident to the Nurnberg Two-Cycle Double-Acting Diesel Engine—Very considerable interest has been taken in the accident to the three-cylinder, two-stroke-cycle, double-acting engine, of 6000 hp., built at the Nürnberg Works in Germany as the first part of a set of machinery of six cylinders, collectively of 12,000 hp., for the center shaft of a triple-screw battleship for the German Navy, the two wing shafts having steam turbines. The accident involved the loss of several lives. An inquiry has been held, and we are informed that it has been ascertained that the accident was caused by the fracture of one of the cam levers of the scavenging valve, and by a part of the lever falling in such a position that the scavenging valve was lifted during the firing stroke of the cylinder. Hence the combustion gases and flame were blown back through the scavenging valve into the scavenging pipe during several strokes. It so happened that the scavenging pipe had a considerable quantity of oil deposited all round inside it, and lying at the bottom of the pipe, due to some previous experiments and absence of drainage. This oil was ignited by the flame from the high-pressure gases and burned rapidly back inside the scavenging pipe until the extreme ends of this were blown out. The discharge-valve covers of the scavenging pump were forced open. The flames issuing at the ends of the scavenging pipes and through the discharge-valve cover openings of the scavenging pump set fire to a tank of oil in the immediate vicinity and to the wooden platforms which had been built all round this engine for observation purposes. These were saturated with oil, and the flames which issued from the broken covers of the ends of the pipes, and the deformed covers of the discharge valves, caused the loss of life. There was not really an explosion in the ordinary sense of the word.—"Engineering," Apr. 19, 1912.

Cheaper Paint for the Navy*

By Henry Williams†

Paint materials form one of the most important classes of naval supplies, and their use has contributed to many officers' reputations for efficiency through the aid they lend in making a "smart ship."

In these days, military efficiency is the main consideration in estimating an officer's value and paint materials cannot be considered as affecting this, other than indirectly. Economy is being urged on all sides, but the proper and economical use of paints generally has not been given serious consideration until recently.

In order that the importance of the subject from this point of view may be judged, the value of the purchases for the Navy for 1910 of the more important paint materials is given:

White lead	$125,000
White zinc	80,000
Red lead	50,000
Linseed oil	100,000
Japan drier	17,000
Turpentine	70,000
Shellac	135,000
Alcohol	49,000

These figures, though only approximate, will serve to show the relative importance from a monetary point of view of the various materials, and also justify the statement that the Navy's annual bill for painting, including the cost of labor, is not far from one million dollars.

Paint manufacturers and chemists have stated their opinion that the Navy's practice in the purchase and use of paint is extravagant and not justified by the requirements, that equally good results could be obtained with much cheaper materials, and that good enough results could be obtained with still cheaper materials.

Ready Mixed Paints—Up to recently practically no use was made of ready mixed paints in the Navy; the raw materials were issued and mixed on board ship when required for application. Early in 1911 a change was instituted by which paints mixed ready for use are issued to naval vessels in place of the raw materials.

It is a well established and generally admitted fact that a compound paint composed of two or more pigments is far more durable than paint made of one pigment only, and that the intelligent combination of several raw materials produces the best results. Furthermore, the mixing of paint on board ship could not be done as effectively as in the navy yards, which have power mills and mixers of the most modern types. Another advantage offered by the issue of ready mixed paints is the facility is affords for the use of newer paint materials, which the Navy should use, if it is to avoid the deserved accusation of extravagance and of being backward.

It seems appropriate to state the characteristics and limitations of the more important of the paint materials now commonly utilized in the Navy.

White Lead—This is the white pigment most generally used and it enjoys a well deserved popularity. It combines with linseed oil, forming an unctuous substance known as "lead soap." This accounts, in a measure, for the popularity of white lead with the practical painter, who by the feel of his brush readily determines whether or not it has been made with white lead. A paint made with white lead alone is not so durable as when white zinc, or "fillers," such as barium sulphate, silica, or similar materials are added.

For naval purposes white lead has one serious defect in its susceptibility to the action of sulphur gases. Generally for this reason the last coat of white paint to be applied to interiors of ships consists exclusively of white zinc.

White Zinc—White zinc or zinc oxide as a paint pigment is about 60 years old and in that time has gained a well deserved popularity. It dries with a hard brittle vitreous surface, in contrast to white lead which produces a chalky surface. Also, in further contrast, white zinc is very fine and white lead is rather coarse, so that in mixtures the interstices between the white lead particles are filled in by those of the white zinc. Mixtures of the two pigments are popular and in the Navy are generally used. Similarly, white zinc is mixed profitably with barium sulphate, silica, etc. Such paints have been used recently in the Navy with good results. Zinc oxide requires a far greater proportion of linseed oil to make paint than does white lead, and this must not be lost sight of in view of the high cost of linseed oil.

Red Lead—Red lead is the oldest of the protective paint pigments. It is used extensively and well thought of among sea-going men. When mixed with linseed oil it acts like plaster of paris mixed with water. The red lead gives off sufficient oxygen to harden the linseed oil and the paint becomes hard and unfit for use. For this reason no pure red-lead paints come ready for use. By the admixture of china clay, silica, or similar inert pigments, this hardening action is prevented. A very satisfactory red lead paint is made from:

65 lb. dry red lead,
10 lb. dry silica,
10 lb. dry china clay,
1 lb. drier,
1 lb. turpentine substitute,
20 lb. raw linseed oil.

Red lead is used on board ship where paint costing less than half as much would give better service. These locations are coal bunkers, double bottoms, trimming tanks, and bilges. The difficulty that is encountered on the average ship in keeping the metal on these locations painted furnishes abundant proof that red lead is not suitable. It is a safe rule to follow that red lead is efficacious only for use as a priming coat, where other kinds of paint are applied over it and in locations where the metal can be rendered absolutely dry before painting. This refers especially to moisture that condenses on the metal in such spaces as double bottoms. Red lead is acted on with ease by sulphur gases when unprotected by another paint. It requires about 33 lb. to mix with a gallon of linseed oil, so that the cost of red lead paint is something over $2 per gal. It is difficult to get painters to apply it properly, due to its weight and the fatigue of handling the brush; there is a tendency to dilute it unduly. Some grades of red lead are coarse and crystalline, and are not so efficient as the finely divided varieties. For this reason one of the laboratory tests is an examination of red lead under the microscope in comparison with a standard sample.

Shellac—The U. S. Navy is probably the largest single consumer of shellac; about half a million pounds are purchased annually and used largely to make varnish for linoleum covered decks of ships. Recently considerable quantities have been used in making ship's-bottom paint.

It is dissolved in alcohol and either Venetian red or yellow ochre is added to give it color and some body. On the average ship large areas of linoleum are "shellacked" each week. The cost of this luxury, over $75,000 annually, is hardly justified, and when the deleterious effect on the linoleum that must be exerted by the alcohol in the shellac is considered, it is a matter of wonder that the custom has continued to prevail so long. Other materials, such as ordinary floor wax, could be used for polishing the surface of the linoleum and the requirement for appearance could be met at much less cost than at present, without sacrificing to any extent the much abused consideration of "sanitary conditions."

Linseed Oil—Linseed oil was the only oil medium for paint for many years, and is the only one at the present time used in the Navy. Due to an unprecedented condition in the linseed oil market, the price has tripled in recent years. The paint industry is the only one that adheres to the use of linseed oil, although there are substitutes that promise well. The most important of these is fish oil, which is produced without the disagreeable odor that marked it formerly, at about half the price of linseed. Its use to a certain extent for naval purposes is likely.

There is no justification for considering fish oil or similar materials as adulterants, and many manufacturers of oil cloths, etc., have found that, when properly treated, it is superior to linseed oil. It can be treated so as to withstand the action of high heat and for this reason

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†Naval Constructor, U. S. Navy, New York.

*Extracts from a paper in the U. S. Naval Institute Proceedings, Vol. 37, No. 4. Reprinted by permission; copyrighted by W. B. Wells, Secretary U. S. Naval Institute, Annapolis, Md.

is valuable for smokestack paint. Maximilian Toch states that its addition, with suitable drier, renders paint more durable to sea air and corrects the chalking tendency of white lead and the hard drying quality of white zinc.

China-wood oil, or Tung oil, cannot be regarded as a substitute for linseed oil, except for certain special uses. Linseed-oil films have not the property of excluding moisture and for that reason linseed-oil paints will not stand well in damp locations. Paints made with Tung oil have the quality of being waterproof and its use in dampproof paints is general for that reason. In spite of difficulty of manipulation, its use is becoming general, not only in paints, but also in varnishes.

Soya-bean oil and corn oil are used for mixing with linseed oil. It has been stated on good authority that as much as 20% of them can be mixed with linseed oil without affecting the properties of the latter, except as to drying.

TURPENTINE—Turpentine has been used for many generations as a solvent for paints and varnishes. Its function is mechanical, being simply to increase the spreading power and working quality. It evaporates leaving no residue, so it cannot be said that it contributes except indirectly to the life or quality of the paint film. When it is realized that entirely too much stress is laid upon its value as a paint vehicle, substitutes will be used that serve the purpose as well and better.

Due to the scarcity of sap turpentine, of recent years so called wood turpentine has been manufactured extensively. This is made by the distillation of sawdust, shavings, old logs and roots of pine trees. The quality of these turpentines depends upon the method and care used in their manufacture, many of them being the equals in every respect, except possibly as to odor, of the sap turpentine. Others have very disagreeable odors and injurious properties due to the products formed in the destructive distillation. For exterior painting these wood turpentines generally are quite as efficient as the sap turpentine. For interior painting their odor in most cases condemns them. In general they cannot be said to have any advantage over benzine products, which are supplied for the same purposes.

The Navy Department purchased in the year 1910 about 75,000 gal. of turpentine under specifications that required delivery of the highest grade of sap turpentine that it is possible to obtain, and consequently at prices somewhat higher than the market. This turpentine was used by the Navy for paints of the sort in which manufacturers of ready mixed paints would not consider using other than benzine products as solvents. Consideration of these facts led to the decision early in 1911 to discontinue the purchase of sap turpentines except for special purposes and to purchase for general use in paints a substitute which had been shown by test to meet all practical requirements. This is a petroleum product similar to benzine, but with higher flash point. It evaporates at a temperature of 212° F. with no residue. Use of the material has met with some opposition, but it is used very extensively commercially for the same purposes as the Navy uses it, and any failure consequently should be considered rather as the fault of the persons using it than of the material. A conservative estimate of the saving to the Navy resulting from the use of the substitute is $30,000 annually. One of the objections advanced is that it causes white paints to turn yellow. This is doubtful. The author holds, too, that very white paint should not be necessary on board ship; expert house decorators, from artistic considerations, favor a cream rather than pure white. This tint permits the use of more suitable varnish in gloss paint.

IRON-OXIDE PAINTS—Large quantities of venetian red are purchased in the Navy for coloring the shellac varnish used on linoleum decks. It consists largely of calcium sulphate or gypsum, the remainder being about 30% iron oxide. Indian red is a natural oxide of iron, practically pure, and is used as a coloring matter in the Norfolk anti-fouling ship-bottom paint, in order that it may be distinguished readily from the anti-corrosive. Metallic brown is another oxide of iron—the best grades being the natural ones. It is used very extensively commercially on steel with success.

BLACK PAINTS—There are many forms of black pigments, all of them practically pure carbon, though they differ in structure and qualities. The one most commonly used in the Navy is lamp-black; it has remarkable tinting strength and the outside paint now used on ships owes its slate color to the addition of lamp-black, the base being of practically the same constituents as the white paint used formerly.

There are a number of graphite pigments, all of them being nearly pure carbon; alone they form an unsatisfactory paint pigment, but added to other heavier bases have great merit.

RED PAINTS—For many years quantities of English vermilion paint were used on naval vessels for painting the inside of ventilator cowls, adding to the smart appearance of the ships in contrast to the white hulls and salmon-colored top sides.

English vermilion is a sulphide of mercury and hardens when mixed with oil. The purchase of English vermilion for the Navy was abandoned a number of years ago for the so called artificial vermilion, which is cheaper, less likely to change color and can be kept mixed. The particular pigment used in the Navy is a lead-barium lake of the azo dye, known commercially as "lithol."

Red, as well as green, yellow and blue paints, do not have the same importance in the Navy as was the case formerly, due to the adoption of the slate color for exteriors of ships. Their use is confined almost exclusively to painting the distinguishing striping on piping on board ships.

BITUMASTIC PAINTS—Specifications for recent battleships require that the builders, in lieu of the red lead and other paints usually required for these localities, shall apply to coal bunkers, trimming tanks, reserve-feed water tanks, inner bottoms in machinery spaces, and bulkheads and foundations in machinery spaces to height of floor plates, the so called bitumastic paints or their equivalents. They promise to play an important part in future painting of the above spaces, which have been a source of considerable worry. Coal-tar products deteriorate when exposed to light and for that reason these materials can be applied only in confined spaces. Formulas for their manufacture have been determined tentatively and, while they should not be regarded as final, they will serve to indicate the character and general ingredients.

A "solution" may be made by melting 100 lb. of coal-tar pitch and 50 lb. of Trinidad asphalt. When liquid the mixture is removed from the fire, cooled and thinned with 65 lb. of coal-tar naphtha and 15 lb. of mineral oil. An "enamel" may be made by melting 350 lb. of coal-tar pitch and 350 lb. of Trinidad asphalt together and boiling for about three hours. A "cement" may be made by melting 150 lb. of coal-tar pitch and 120 lb. of Trinidad asphalt together and boiling for about three hours, when 150 lb. of Portland cement is stirred in. In all of these care is required in the heating; the quality of the material is dependent entirely on this.

The "solution" is applied first in all cases, brushed on cold. In some spaces the other materials are unnecessary, though it is best generally to follow up with the "enamel" or "cement," both of which must be hot. The former goes on in thickness of about $\frac{1}{16}$ in., the latter about ½ in. The cement is applied only to the bilges in the machinery spaces; in the firerooms frequently it is protected by a covering of portland cement.

These materials have been used extensively on merchant ships for many years. In 1904, the author inspected the "St. Louis," which had had bitumastic materials applied at the time of building (1894-1895) to trimming tanks, chain lockers, double bottoms, coal bunkers and inner bottoms. The original material was in good condition and had received only minor repairs. The metal underneath generally showed no signs of corrosion and in many cases the hammer marks around rivet heads could be seen when the bitumastic was removed.

INERT FILLERS—For many years white

lead, white zinc, linseed oil and turpentine have been regarded as the standard ingredients of which any paint should be made. Many manufacturers quietly utilized other materials that gave results quite as good, but the consuming public grew up to regard as adulterants many other pigments which have excellent qualities. Among these may be mentioned lithopone, blanc fixe, barytes, whiting, gypsum, china clay and silica. Exposure tests at the seashore showed that paint in which the much despised barytes was a principal pigment gave as good results as one made up with only white lead and white zinc. Many of the numerous paints used on agricultural implements are made largely from barytes and the results obtained should be a sufficient lesson to the Navy that its paint money could be spent to better advantage than in the exclusive purchase of lead and zinc paints.

Lithopone is a remarkably fine white pigment consisting of about 70% of barium sulphate and 30% of zinc sulphide. It is not suitable for outside paint. Blanc fixe is barium sulphate, artificially produced, and is superior to barytes in its fineness and texture. It has many qualities to recommend it for naval purposes and experiments show excellent practical results. Slate-color paint for outside of ships made according to the following formula has given excellent results in preliminary tests:

450 lb.	blanc fixe, dry.
70 lb.	French ochre, dry.
467 lb.	white zinc, dry.
93 lb.	graphite in oil.
3 lb.	lamp black in oil.
93 gal.	raw linseed oil.
12 gal.	oil drier.
8¾ gal.	turpentine substitute.
2 gal.	benzine.

Barytes is well known as the white mineral barium sulphate. Used alone it has little covering power, but when mixed with white zinc or white lead it gives excellent results. It should show durability as a paint pigment, as it is one of the most permanent of the minerals and is insoluble in most solvents.

Whiting, or calcium carbonate, is used mainly for making putty, but small percentages are used by many manufacturers in all paints for the purpose of neutralizing any acidity that may develop. This recommends it for paints for steel. Gypsum, or calcium sulphate, is the main ingredient of venetian red, of which large quantities are used by the Navy; the remainder being ferric oxide. In its pure state it is used to advantage if free from lime. China clay is used mainly as a filler for paper, but has considerable value in paint mixtures.

Silica is useful in mixing with other pigments, largely because of its quality of presenting an excellent surface for repainting. This quality alone should recommend it for use in many of the paints used on ship-board. Asbestine is a silicate of magnesium, and is fibrous in character. It is extremely stable and when used in mixed paints has a tendency to hold up the heavier pigments and to keep them from settling to the bottom of the container.

VARNISHES—The varnishes intended for outside use, usually known as "spar varnishes," are made with the better and harder gums and do not contain so much volatile solvent; consequently they dry more slowly. Varnishes for interior use are usually not so expensive, have more volatile solvent and dry much more rapidly even in confined spaces.

Damar varnish, made from damar gum and turpentine without the use of oil, is used in mixing enamel paints for interiors of living spaces on ship-board. It was selected for this purpose due to its light color, although it is not so durable as the linseed-oil varnishes. With a slight sacrifice of whiteness, a gloss paint could be made by using an oil varnish that would be much more durable and cost no more. The flat-wall finishes made from lithopone that have become popular recently, contain a small percentage of varnish and for that reason will stand scrubbing quite as well as gloss paint made with damar varnish.

Asphaltum varnish is made in the same way as other oil varnishes by using a fossil asphalt, known as gilsonite, with linseed oil and a solvent. This kind of varnish has not very great durability.

RUST-PREVENTING PAINTS—A number of paints have been designed especially to prevent rusting of steel.

A paint that has been used extensively in steel work of recent buildings contains a mixture of oxides of silica, calcium and aluminum, closely resembling portland cement, which is mixed with other materials and china-wood oil. The latter has the property of forming a moisture-excluding film, while the cement absorbs, when applied, moisture that may be present on the surface and permits the use of such a paint on moist surfaces. These latter characteristics are sufficient to justify the substitution of such a paint for many localities in which red lead now is used. Its price, one-third less than that of red lead, and its protective and rust-preventing qualities, which have been shown by experiment to equal if not surpass red lead, are added reasons in favor of the adoption of such a paint for naval vessels.

A paint that has given excellent results when used on the interiors of trimming tanks of submarines is made with a graphite pigment and an asphaltic oil thinned with benzine. This paint has displayed remarkable protective qualities when used under the trying conditions mentioned above and its cost is less than $1 per gal.

Another paint that has been tested extensively at the Brooklyn Navy Yard, for uses to which red lead has been put, is composed of a pigment similar to venetian red, containing iron oxide, calcium sulphate and silica, and of specially high quality of linseed oil, turpentine and driers. The merit of this paint appears to be due to the special quality of the linseed oil and the care used in manufacture, and, though it is somewhat more expensive than the others mentioned, the paint is much cheaper than red lead and appears to be more effective.

CONCLUSIONS—An important consideration, and one that should not be lost sight of in connection with the paint situation in the Navy, is the fact that rarely is paint allowed to live its full life, or the paint film to perish through the action of the elements. Occasionally in inaccessible places on ship-board the metal becomes badly corroded, either under paint, or else due to its absence. These cases are unimportant and can be attributed generally to the unsuitability of the paint used. Most of the paint, however, that is used on ships is painted over before it has perished. Ample proof of this is the thickness of the paint on various parts of old ships, and the scaling of old paint that goes on continually on men-of-war. Granting, for the sake of argument, that the new paint materials, such as turpentine substitutes, linseed-oil substitutes, the inert fillers, etc., have not the durability of the materials heretofore used, it would even then be unreasonable to use them.

The New Jersey Public Service Commission has decided, in the case of the Board of Trade of New Brunswick vs. the Delaware & Raritan Canal Co. and the Pennsylvania R.R. Co. (lessees), that it has no jurisdiction over the rates of certain canal companies. The charter of the canal company was granted in 1830 and one section reads as follows:

Said companies are hereby authorized to demand and receive such sum or sums of money for tolls and the transportation of persons and every species of property whatsoever on said canal and feeders as they shall from time to time think reasonable and proper, provided that they shall not charge more than at the rate of 4c. per ton per mile. . . ."

The Commission, while admitting its lack of power, reminds the public that proper control may possibly be secured with the canal company's assent at some later time when the company desires to increase its facilities or readjust its operations. The Commission has, therefore, made a memorandum bearing on the rates which should exist after the state has secured control. It finds that a classification of tolls on canal borne traffic, if reasonable, is a just and proper method of charging for use of the canal and that a uniform charge per ton-mile . . . all canal borne traffic irrespective of weight, bulk, value or other considerations would be less reasonable than a proper classification.

The Commission finds that the temporary closing of a canal, when required by necessity for repairs otherwise impracticable and to the extent of that necessity, is justifiable. It finds also that when seasonal conditions render traffic virtually impossible, the closing of the canal is not unreasonable.

Tests of a Simple Engine Taking Steam at Less than Atmospheric Pressure*

By R. C. Carpenter†

So far as the writer can ascertain, there are very few data available as to the economy of reciprocating engines when operating with less than atmospheric pressure, although numerous tests have been made of nearly all types of engines under the usual conditions of steam pressure and vacuum. A considerable amount of data is to be found as to the results of steam-turbine tests, especially when of large size, operating with steam of low pressure. The impression generally prevails that the steam turbine produces much higher economy than the steam engine when operating with steam of less than atmospheric pressure.

The investigation, the results of which are given here, cannot be said to prove that the general opinion as stated above is erroneous, but it does tend to indicate that the reciprocating piston engine of small clearances can be operated with low steam pressures and high vacuum with remarkable economy.

The particular engine which was investigated was of the four-valve type and with cam-operated valve mechanism arranged to open and close with great rapidity. The total clearance space was about 1% of the piston displacement. The valves were located so as to make the losses due to clearance a minimum. The results obtained in the investigations could not, in my opinion, have been produced by any engine built ten years ago.

The engine in question was 24 in. in diameter with 24-in. stroke. It was double acting with admission-valve seats on the barrel of the cylinder near the end, and exhaust-valve seats in the heads. This engine was developed to furnish power from steam generated by the heat of the sun in plate boilers which presented a large absorption surface and were designed by F. Shuman, General Manager of the Sun Power Co., of Tacony, Penn.* Its general features were conceived by Mr. Shuman. The engineering features were designed and developed by E. P. Haines.

The engine was developed to meet a special demand for a steam motor of small power that would give the highest possible economy with low steam pressure and a high vacuum. Its design and construction were undertaken by Mr. Shuman after he had thoroughly investigated the possibilities of obtaining a commercial engine or turbine which would meet his requirements. The best guaranteed performance for a 25-hp. steam turbine which he could obtain from any builder was about 60 lb. per b.hp. per hr. with steam of atmospheric pressure and a vacuum of about 28 in. No such turbine has been built and in the proposals the cost of development would have fallen principally on Mr. Shuman had one been built. As the motor was to be employed for driving a pump, the reciprocating engine at moderate speed possessed many advantages over the turbine. Mr. Haines was quite certain from his preliminary studies that he could construct an engine of about 20 hp. capacity which would produce a brake horsepower with less than 40 lb. of steam per hour. Several attempts were made before final success was attained; in one of which attempts the entire cylinder and head were lined with soapstone in order to reduce the heat losses. Although this experiment was very expensive, it did not accomplish the desired result. Mr. Shuman only proved by that experiment what was already well known to scientific men, namely, that the principal loss of heat in the steam engine is due to the deposit and re-evaporation of a film of water on the interior walls and not to the loss of heat through a good conducting material.

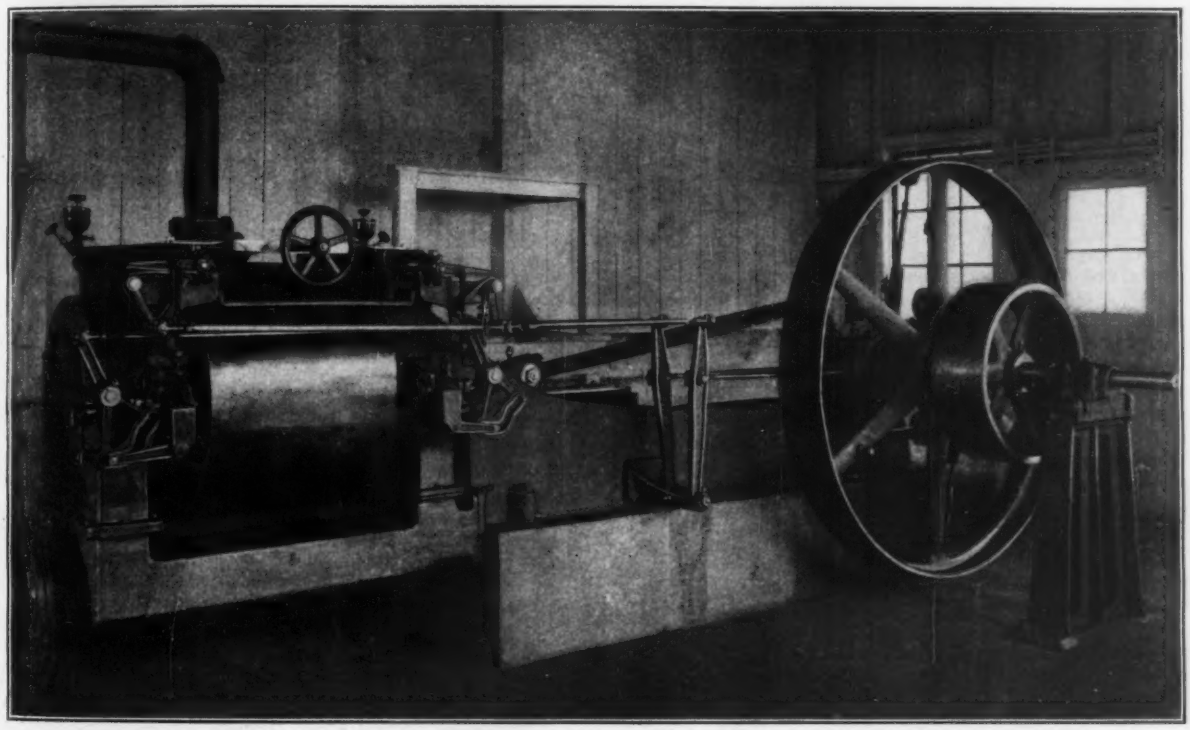


Fig. 1. The 20-hp. Shuman-Haines Low-Pressure Steam Turbine

The Engine—In general appearance the engine was not greatly different from other engines of similar size, except that its working parts were light and it was provided with a rather long connecting

*A paper from the Engineering Research Department of Sibley College, printed in "Sibley Journal of Engineering," May, 1912.

†Professor of Experimental Engineering, Sibley College, Cornell University, Ithaca, N. Y.

*See Engineering News, Sept. 21, 1911. —Ed.

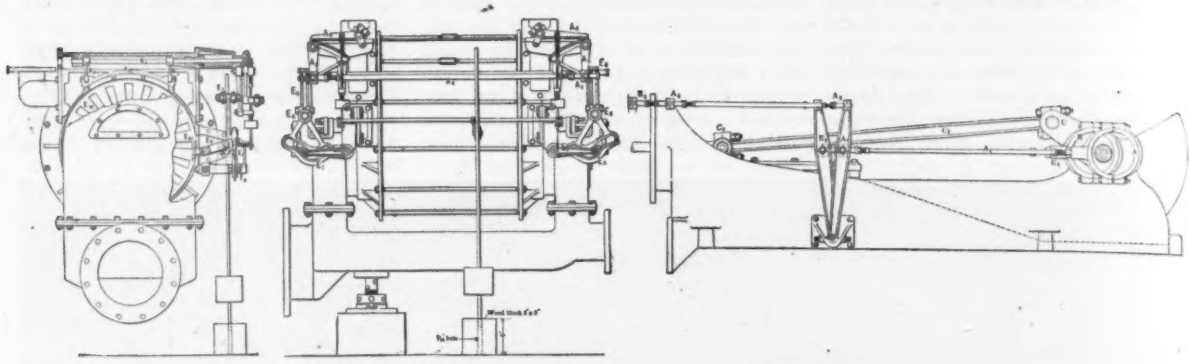
rod. It had an overhung crank and an outboard bearing. Its general appearance is shown in Fig. 1. It could be turned readily by hand, showing that the friction loss was small.

The general arrangement of the valve-driving system and the valves can be seen from Figs. 2, 3 and 4. *A* followed by numerals indicates parts of the admission-valve system, and *E* followed by numerals represents parts of the exhaust-valve system. Two eccentrics were used which drove rocker arms, one of which *A*, Fig. 4, operated the steam valves, and the other *E* the exhaust valves. A cross-section of the admission valve and its driving linkage is shown in Fig. 2. Generally speaking, the valves were constructed so as to reduce the clearance space to the lowest possible limit.

The steam-admission valves, two in number, were of the slide-valve type, arranged to move parallel to the axis of the cylinder on a curved seat concentric with the cylinder. The steam-valve stems were driven by cams A_5, lifting A_6, Fig. 3, against the action of a spring. The oscillation vibrated the bell-crank lever of Fig. 2, which motion was communicated by links to the valve A_{10}, Fig. 2, and gave it a sliding motion on its seat. This design afforded steam ports with an opening 20% of the piston area. These are on the top part of the barrel of the cylinder near each end and are provided by this construction with extremely short passages into the cylinder, thus making a small clearance loss.

The exhaust valves in this construction are especially novel; they consist of thin steel plates situated inside the cylinder heads and are vibrated in a plane perpendicular to the axis of the cylinder. Such valves are extremely unusual in the construction of steam engines and their operation was studied with a great deal of interest. In structure the valve was a flat thin disk provided with slots which were made to register with corresponding openings in the seat by the action of the valve-moving mechanism. It worked smoothly during the test; it was tight and its continued use apparently increased its tightness. The fact that it was very thin and that it was held in position by the pressure inside the cylinder, doubtless explains why the results were so good.

The exhaust valve is shown at E_1, Fig. 2, from which it will be noted that the area of the exhaust ports when open is very large. It amounts to 35% of the piston area. The exhaust valves are vibrated by connecting to the eccentric *E*, Fig. 4, through the medium of rocker arms, links and cams shown in Figs. 4, 3 and 2.



FIGS. 2, 3 AND 4. ELEVATIONS OF THE SHUMAN-HAINES ENGINE
(End view with section through exhaust; side elevation of cylinder; elevation of frame and eccentrics.)

The steam pipe is shown in the upper left-hand corner of Fig. 2, where it joins on to the steam chest. The exhaust-steam pipe is shown beneath the cylinders in Figs. 2 and 3.

THE TEST—The test of this plant was conducted at Tacony, Penn., by Prof. W. M. Sawdon and myself. Because of the fact that the steam pressure was very low and that the work was done almost exclusively with less than atmospheric pressure, the method of testing which had to be adopted was quite unusual.

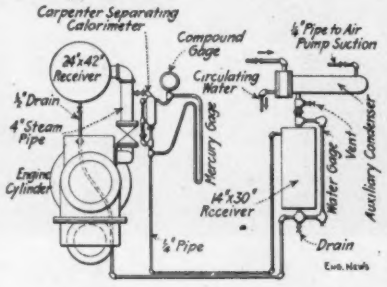


FIG. 5. DIAGRAM OF CONNECTIONS; SEPARATING CALORIMETER FOR STEAM AT LESS THAN ATMOSPHERIC PRESSURE

The engine was arranged to exhaust into a surface condenser connected to a vertical air pump. The water of condensation was delivered by a special hotwell pump into one of two tanks, which were placed on weighing scales and provided with suitable pipe connections and valves so that one could be filling while the other was emptying. The hotwell pump was provided with a governor for maintaining a constant level in the hotwell. Observations of the water level were also taken by means of a glass gage, and a correction applied for differences of level whenever necessary.

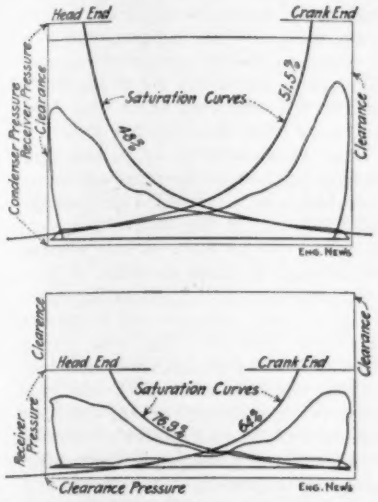
The engine took its immediate steam supply from a receiver 24x42 in. The receiver was supplied with live steam from a low-pressure solar boiler situated in another building and some distance away, and it also received the exhaust steam from the air pump which produced the vacuum on the system. The live-steam connection from the boiler was provided with a valve by means of which the pressure was maintained constant by hand regulation. The main supply pipe was exposed to the weather, which was quite cold at the time of the test; as a result a considerable amount of water discharged into the receiver from both sources of steam supply, the height of which was determined by a glass gage and was regulated by a valve on a drain pipe. During some tests, it was sometimes desirable to drain the receiver when the pressure was less than atmospheric; this was accomplished by connecting the drain pipe to an auxiliary receiver, which was connected to the suction side of the air pump and thereby kept under vacuum.

The steam pressure was measured by a U-tube mercury manometer attached to the steam pipe near the steam chest. This was kept as nearly constant as possible by hand regulation of the live-steam valve controlling the admission of steam into the large receiver. The vacuum was measured by a cistern mercury manometer connected to the condenser.

The temperature of the steam was taken by a thermometer placed in the steam pipe near the cylinder. The temperature of the exhaust was taken by a thermometer well in the exhaust near the cylinder. In general, all thermometers and pressure gages were very carefully compared with standards before and after the test, and the results corrected as necessary.

In order to guard against any water vapor in the discharge from the air pump which should have been charged against the engine, it was condensed, by discharging through a long pipe extending some distance outside the building. It then passed through a trap, was weighed and considered as steam consumed by the engine.

A gasometer was also placed in the air-pump discharge and so arranged that



FIGS. 6 AND 7. TYPICAL CARDS FROM THE SHUMAN-HAINES LOW-PRESSURE ENGINE

the volume of air pumped in a given length of time could be measured.

Quality determinations of the steam entering the cylinder were necessary in order to obtain accurate results, for the reason that the steam supplied to the main receiver, as already noted, contained a considerable amount of moisture. This problem was a very unusual one, as it required the determination of the moisture in the steam supplied at atmospheric, or less than atmospheric, pressure. In the tests made, the steam pressure varied from slightly above atmospheric pressure to about 7 lb. below.

The scheme of arranging a calorimeter for working under such conditions was quite original and was worked out in detail by Prof. Sawdon. The results which were obtained were proved, by subsequent tests, to be quite accurate. A separating calorimeter was connected in an auxiliary steam line extending from the main steam pipe to an auxiliary receiver, on which the same vacuum was maintained as on the engine, and through which a fair sample of steam could be drawn by suction. The scheme adopted is shown diagrammatically in Fig. 5. The quality of the steam in most of the tests which I conducted, did not differ greatly from 96%. In a few of the tests conducted with very low pressures the quality approximated 90%.

Indicator diagrams were taken during the test, special springs being carefully calibrated for the pressure conditions under which they were operated. Fig. 6 represents the type of indicator diagram which was obtained when the entering steam, as measured in the receiver, was about ½ lb. above that of the atmosphere. Fig. 7 represents the form of diagram when the initial steam in the receiver was about 7 lb. less than that of the atmosphere. On both the diagrams submitted, a saturation curve is drawn as a reference line. It will be noted that the expansion line is a long distance from the saturation curve at the point of cutoff, especially for the case of the higher steam pressure. However, it will be noted that these lines intersect before release, indicating that the moisture during expansion had reëvaporated.

With steam about 1 lb. above atmospheric pressure and with a vacuum of 28 in., the engine required 31.6 lb. of steam per b.hp.-hr. With the same steam pressure, but with a vacuum of 28.8 in., steam consumption was 28.8 lb. per b.hp.-hr. These two tests indicate the very material effect of a high vacuum under such conditions of pressure.

With a steam pressure of about 8 lb. absolute (6.75 below atmosphere) and 27 in. vacuum, 37.8 lb. of steam were required per b.hp.-hr. With the same steam pressure but with a vacuum of 28.66 in., 35.7 lb. of steam were required per b.hp.-hr.

As compared with the Rankine cycle, the efficiencies vary from 43.8 to 52.4%, depending on the load and steam pressures. On the whole, the results will certainly compare favorably with any published results of any small steam turbines which I have seen.

An independent test of the same engine was made by E. P. Haines a few weeks previous to the tests made under my supervision, and these tests showed substantially the same results.

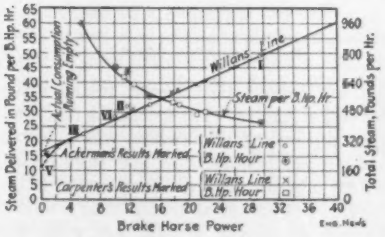


FIG. 8. DIAGRAM OF TEST RESULTS ON LOW-PRESSURE ENGINE

A. S. E. Ackermann, a noted mechanical engineer of London, England, made a series of independent tests on this engine a few months later than those which I have reported. Mr. Ackermann sent me th general results of his tests and also a diagram on which he had plotted his results and those which I obtained. His diagram is appended (Fig. 8). This diagram was constructed by using the total brake horsepower as abscissas and the total water consumption as ordinates. The plotted results all fall remarkably near a straight line. The fact that the results of the tests of many kinds of prime movers, when plotted in a similar way, fall in a straight line, has been proved by numerous experiments, and this empirical law is for this reason a great aid in determining the accuracy of independent tests made on the same prime mover. The fact that my tests and Mr. Ackermann's fall on the same straight line indicate the substantial accuracy of both series of tests. The straight line which characterizes results plotted as explained is frequently referred to as Willan's line, Mr. Willan being a noted English engineer who first pointed out the existence of such a relation. The diagram also shows the steam per brake horsepower per hour for different load conditions.

A New Feature of Wave Impact has been investigated theoretically and experimentally by Prof. A. H. Gibson, who presents his results in a paper before the Institution of Civil Engineers (England). When waves strike the seaward face of a seawall or breakwater, stones in this face are sometimes lifted outward toward the advancing wave, evidently by a pressure beneath. It has heretofore been recognized that the energy of the advancing water would have an action which might explain this phenomenon: The pressure of the moving water against the water lying in the joints of the masonry would produce a pressure similar to the pressure of a jet, and this, being transmitted directly to the back of the stone when the joints in the masonry are entirely filled with water, or transmitted by air compression if the joints are not completely filled, would produce a pressure at the back of the stone equal to that which the moving wave produces at the front. Since the two pressures might not be exactly simultaneous, or the pressure might be transmitted to the back of a stone which was not at that moment being struck by the wave, lifting out of stones could occur. Prof. Gibson, however, believes that much greater pressures must occur under the phenomena as observed. He is able to account for such greater pressures by assuming that water-hammer impact occurs in the joints of the masonry. He reports a number of experiments on pipe and other aggregations arranged to simulate the conditions which may exist in the masonry joints when filled or partly filled with water, showing that great rise of pressure actually is noted. He concludes:

The effective internal pressure due to wave impact on the assumption of simple hydrostatic transmission of pressure cannot exceed that exerted by wave impact on the sea face.

If the energy of the wave is devoted to compression of air in the open joints, the pressure produced may amount to approximately twice the face pressure.

If, however, conditions are favorable to the production of water hammer, considerably greater internal pressures (up to some fifteen times the face pressure with very high velocities of impact) are to be regarded as possible.

The results suggest the desirability of providing a free outlet for such water as may circulate through the interior of a seawall or breakwater.

Electrolysis Investigation and Ordinance at Chicago

In connection with the electrolysis survey of Chicago, which has already been noted in ENGINEERING NEWS, Jan. 25, 1912, special tests were made on the new Mandel Bldg. (Madison St. and Wabash Ave.) in order to determine the conditions in relation to the structural-steel work. The tests were made under the direction of Ray Palmer, now City Electrician, and were carried on in co-operation with the public-utilities corporations (including the telephone, gas and railway companies). Since that time an ordinance has been introduced to provide against such conditions, and is now before the council. This was prepared by Mr. Palmer, and we are indebted to him for information as to the tests and the ordinance.

TESTS ON THE MANDEL BUILDING

These tests were made between 8:55 and 10:10 p.m., Feb. 1, and a condensed record is given in the accompanying table. Observations were made each minute. In order to determine the source of the current flowing out of the building over pipe lines and structural-steel work it was necessary to shut down the feeding sections of the elevated railway, the street railways and the Illinois Tunnel Co. All of the readings were averaged maximum deflections.

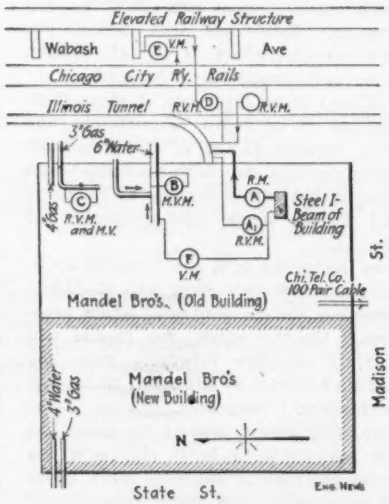
During the test three 24-hour recording instruments were in service. The first of these (*A*-1, see accompanying figure) showed that the potential between the structural steel of the building and the rails of the Illinois Tunnel Co. varied from 1 volt between 1 and 5 a.m. to a maximum of 8 volts between 5 and 6 p.m. At 9:03 p.m., a maximum of 190 amperes flowed out from the structural steel to the rails when the maximum voltage was 3.2 volts.

The second instrument (*C*) showed that the current flowing east out of the building over a 3-in. wrought-iron gas pipe varied from 6 amperes between 2 and 5 a.m. to a maximum of 212 amperes at 8:15 a.m. A calibration of this pipe makes a 1-millivolt drop over 5 ft. 10 in. of pipe equal to 5.97 amperes. The maximum flow out of the building over this pipe line during the test was 65 and 71 amperes, at 9:04 and 9:37 p.m., respectively. The third record (*D*) showed that the elevated-railway structure was positive to the Illinois Tunnel rails from a minimum of 9 volts between 7:45 and 8:30 a.m. During the test this voltage varied from 1.5 to 3 volts under normal operating conditions.

INCOMING CURRENT—From former tests it was found that some of the current was coming into the building over the Illinois Tunnel Co. telephone cable sheaths, but most of it to the structural-steel work through the steel-column footings. There are no means of determining what amperage the different columns are carrying into the building without calibrating them. It was found that the 4-in. wrought-iron water pipe and 3-in. wrought-iron gas pipe were carrying 10 and 24 amperes, respectively, out of the building, on the State St. side of the new building. A Chicago Telephone Co. 100-pair 22-gage service cable was carrying from 3.5 to 40 amperes of current out of the building over its lead sheath on the Madison St. side during this test.

CONCLUSIONS—The following conclusions are drawn from the facts and figures of the report:

(1) A very dangerous condition exists in this Mandel Bldg., due to the electric currents which have strayed from the defective return circuits of the elevated, surface and tunnel companies to the structural-steel work of the building and through it to the piping systems of the building, which finally carries the current out toward the nearest tracks and elevated structure. The indicating records taken during the test (which was a low-load period) plainly show that from 9:03 to 9:05 p.m. an average maximum of 251 amperes flowed out of the building toward Wabash Ave. over a 3-in. gas pipe, a 6-in. water pipe and a No. 0 copper cable connecting the structural-steel work of the building in the fourth basement to the rails of the Illinois Tunnel located directly under Wabash Ave. Both pipes were of wrought iron. An average of 49 amperes flowed over the gas pipe, 29 amperes over the water pipe and 173 amperes direct from the steel work over the copper-cable connection.



PLAN OF ELECTRICAL CONNECTIONS FOR TESTS OF STRAY CURRENTS AT THE MANDEL BUILDING, CHICAGO

(The letters relate to the columns of the accompanyipg table.)

The recording charts of voltage between steel of building and the Illinois Tunnel rails) and of amperage flowing out of the building over the 3-in. gas pipe show that the curves are similar in appearance and typical of street- or elevated-railway operation curves, with the peaks occurring between 7:30 and 9 a.m. and between 5 and 6 p.m. The latter chart shows that at 8:15 a.m. on Feb. 2, 212 amperes (which is three times the maximum flow during the test period) flowed out of the building over the gas pipe, while the former chart shows 8 volts maximum at this same period, which is 2½ times the maximum voltage during the test. This indicates that with all other conditions remaining normal, 475 amperes would flow out of the building from the steel work at the time when 212 flowed over the 3-in. gas pipe.

These large amounts of current cannot help but damage the pipes and structural-steel work, embedded in concrete which is damp in the lower basements. All joints will be more or less affected and damaged by these currents. A 6-in. sprinkler-system pipe burst in the center of this building last year, due to damage from stray currents. The wire netting which is used in the concrete surrounding the iron and steel work has been found to be negative to the adjacent metallic work in most places. This condition, which is damaging to these structures, will eventually result in weakening the ultimate strength until they give way, unless the stray-current leakage is soon stopped by these railway companies. Additional information can be obtained upon these local conditions by stripping the gas pipe which shows a path of high conductivity into Wabash Ave., so as to find out where this current is going and what damage it is doing.

(2) About 25% of the current which flowed out of the building under normal conditions during the test period was surface-railway current; about 35% was elevated-railway current, and about 40% was tunnel current, as shown by the test records. These percentages vary from time to time as the relative loads change. The switches controlling all power generated within the building were pulled at 9:45 p.m., without showing any noticeable effect upon the stray currents (see table).

(3) Although the surface tracks have been rehabilitated throughout this district the return currents still leak and stray, due to the installation of defective or insufficient conductors in their return circuits.

(4) The uninsulated loop elevated structure, which is being used as the only elevated return conductor in the loop, is defective as a return conductor and of insufficient current-carrying capacity to keep the return currents of the elevated railway from straying and damaging adjacent structures.

(5) The Illinois Tunnel Co.'s return conductors are defective and of insufficient conductivity to keep the return cur-

TABLE OF RECORDS OF FLOW OF CURRENT AT MANDEL BUILDING, CHICAGO (FEB. 1, 1912)

(Letters at head of columns refer to accompanying plan)

Time	A Steel of bldg. to tunnel rails	B Drop on 2½ ft. of 6-in. w.i. water pipe line		C Drop on 5 ft. 10 in. of 3-in. w.i. gas pipe line		D From elev. ry. structure to tunnel rails	E From st. ry. rails to el. ry. structure	F From steel of bldg. to water pipe	Switches out
	amperes	m.v.	amperes	m.v.	amperes	volts	volts	m.v.	
8:55	140	0.6	26	8	47	3.0	0.6	2	
8:59	140	0.6	26	9	53	2.0	1.0	2	
9:00	90	0.4	17	4	24	1.0	0.6	— 7	Elev. rys. and st. rys.
9:02	90	0.4	17	3	18	1.6	0.7	—10	
9:03	190	0.7	30	4	24	3.4	1.6	+ 4	
9:04	160	0.6	26	11	65	2.8	0.6	2	
9:24	120	0.5	22	10	59	2.0	0.5	3	
9:25	80	0.3	13	9	53	1.0	1.5	20	Ill. Tun. Co.
9:28	110	0.4	17	9	53	2.3	0.4	24	
9:30	50	0.4	17	8	47	1.2	1.5	24	I. T. Co. and elev. ry.
9:33	140	0.4	17	5	30	2.4	0.5	20	
9:37	140	0.6	26	12	71	4.0	0.5	2	
9:45	130	0.6	26	9	53	2.0	0.25	3	M. Bros. out
9:45½	110	0.4	17	10	59	2.2	0.7	5	M. Bros. in
9:59	120	0.2	9	9	53	2.9	0.3	22	
10:00	60	0.0	0	7	41	1.9	0.3	20	St. rys. and Ill. Tun.
10:01	55	0.0	0	8	47	1.7	0.2	24	
10:02	50	0.0	0	7	41	1.2	0.2	17	
10:04	70	0.2	9	9	53	2.4	0.8	19	I. Tun.
10:10	140	0.5	22	10	59	2.8	0.8	2	

Notes to table.—A. Electrical readings between the structural steel work and the tunnel rails. The voltage varied from a minimum of 0.7 when the steel was connected by a No. 0 copper cable through the ammeter to the tunnel rails, to a maximum of 3.2 volts whenever the cable was not connected.

B. Current flowing out of the building over a 6-in. wrought-iron water pipe in the fourth basement. This current in the pipe reversed its flow to an average maximum of 9 amperes when the structural steel work was short-circuited through the ammeter to the tunnel rails.

C. Current flowing out of the building over a 3-in. wrought-iron natural-gas pipe in the first basement.

D. Voltage between elevated-railway structure and tunnel rails.

E. Voltage between the street-railway rails and elevated-railway structure.

F. Millivolts indications between the steel of the building and the 6-in. wrought-iron pipe in the fourth basement.

rent from straying and damaging these structures. The tunnel lighting circuit is not properly constructed to protect substructural metallic work from damage by stray currents. Instead of the 250-volt incandescent lighting circuit being wired direct between the trolley and rails, or an insulated return conductor, it is wired from the trolley through the incandescent lamp to the automatic-telephone cable sheath which carries the current into this building, where it is distributed over pipes and steel work which finally carries it back to the main return.

(6) No concerted action has been taken by the railway companies to clear up the dangerous situation which exists at this location, although the officers of these companies have been notified of the conditions.

(7) A pipe and cable sheath drainage system (such as has been proposed by the sub-committee for solving the electrolysis problem) will not better these local conditions if installed as recommended, but will have a tendency to increase the stray-current leakage to the pipes and other substructural metallic work in this vicinity.

(8) These local conditions will be materially bettered by reducing the voltage drop to a low practical minimum in the return circuits of these different companies, and afterward applying the remedies as recommended in the preliminary electrolysis report (insulating pipe joints and grounded steel work).

Proposed Ordinance to Prevent Damage by Electrolysis

This has been approved by the Council committee on gas, oil and electric light, but has not yet been passed on by the City Council. In regard to the limits specified for current (amperes) flow on pipes and cable sheaths, it is stated in an explanation prepared by Mr. Palmer that tests show these amounts to be safe allowances:

Calked Cast-iron Pipe—Tests show the average joint resistance will safely approximate 50 ft. of pipe which, with an allowed maximum joint resistance of $\frac{1}{10}$ volt over the joints, will make an approximate allowance of 1.5 amperes per pound-foot, and with a factor of safety of three a safe allowance of 0.5 ampere per pound-foot.

Wrought-iron and Mild-steel Pipe—Tests show wrought-iron screwed joints (couplings) have an average resistance equal to the same length of pipe. A fair approximate allowance per pound-foot is 24 amperes, assuming a resistance of wrought iron of 0.000188 ohms per pound-foot which, this, with a safety factor of three, makes a safe maximum allowance of 8 amperes.

Lead-pipe and Cable Sheaths—Tests show practically no difference between the resistance of pure lead and cable-sheath lead alloy up to 3% of tin. The same resistance value of 0.000495 ohms per pound-foot is therefore used. The determining factor of the current flow on cable sheaths having uniform resistances should be increased rise of temperature. Tests show that a flow of 32 amperes per pound-foot of cable sheath causes a rise in temperature of 5° C., which with a safety factor of two makes a safe allowance of 16 amperes.

(1) All uninsulated electrical return circuits must be of such current-carrying capacity and so arranged that the difference of potential between any extreme feeding points on the return and the feeding station will not exceed the limit of 12 volts, or between any two points on the return 1000 ft. apart will not exceed the limit of one volt. In addition thereto, a proper return-conductor system must be so installed and maintained as to protect all metallic work from electrolysis damage. The return-current amperage on pipes and cable sheaths must not be greater than 5 amperes per pound-foot for calked cast-iron pipe; 8 amperes for screwed wrought-iron pipe, and 16 amperes for standard lead sheaths of cables containing 3% of tin or less.

(2) All persons, firms or corporations operating railways must equip their uninsulated return-current systems in the following manner: (A) With insulated pilot wire circuits and voltmeters, so that accurate chart records will be obtained daily showing the difference of potential between the negative bus bars in each station and at least four extreme limits on the return circuits in its corresponding feeding district; (B) with recording ammeters, insulated cables and automatic reverse load and overload circuit breakers which will record and limit the maximum amperes drained from all the metallic work (except the regular return feeders) to less than 10% of the total output of the station. The said chart records must be so kept as to be always accessible to city officials.

(3) Any person, firm or corporation failing to comply with the provisions of this ordinance after six months from the date of its passage shall be fined not less than $50 nor more than $200 for each offense; and each day's operation of such equipment contrary to said provisions shall constitute and be regarded as a separate and distinct offense.

Two Geared Turbine Steamers have recently been built for the London & Southwestern Ry. Co. to run across the English Channel between Havre and Southampton. These vessels were described by Prof. J. H. Biles in a paper read at the spring meeting of the Institution of Naval Architects in London during the last week in March. Prof. Biles said that the adoption of the geared turbine was decided upon for two reasons: First, for the reduced steam consumption, and second, to enable slower running, larger diameter propellers to be adopted. The railway company referred to had recently put in service two three-screw turbine-driven vessels for the Channel Islands service. These vessels have propellers 5½ ft. in diameter, which are run at 500 r.p.m. In the new vessels with two-screw geared turbines, the screws are 6 ft. in diameter and run at 300 r.p.m. While the vessels with the turbines directly on the propeller shaft show a steam consumption for all purposes of 17.1 lb. per hp.-hour, the contract trials of the geared turbine vessels show a steam consumption of 14.3 lb. per hp.-hour. Tests have shown that 2.3 lb. of this steam is used in the auxiliary engines, so that the net steam consumption of the turbines driving the vessel's screws is 12 lb. per hp.-hour. In a six-hour run, the direct-drive vessel consumes 29 tons of coal and the geared-turbine vessel 18 tons. There was some fear that the geared turbine might be too noisy for use on passenger vessels, but Prof. Biles said that only by listening carefully in the passenger quarters could a slight whistling sound be heard, something like a small steam escape. It was of too trifling an amount to affect in any way the passengers' comfort. It was also found that the geared-turbine vessel was even freer from vibration than the direct driven vessel.

A Factory's Duplex Water-Supply with Interlocked Valves

An unusual arrangement was provided in the new factory of the Bosch Magneto Co., at Springfield, Mass., in connection with the problem of securing a city water supply for drinking and fire purposes to supplement the factory well-water supply. The factory lies on the boundary between the cities of Springfield and Chicopee, and has access to the water mains of both towns. Since both town systems have a satisfactory pressure (110 and 140 lb., respectively) it was desired to make connection to both in order to have the fire-pipe system of the factory as reliably supplied as possible. However, the Springfield Water Department objected to a simultaneous connection to both systems unless adequate precautions were taken to prevent the possibility of Chicopee water entering the Springfield mains. To effect this the designing engineer of the plant, A. R. Klein, designed the interlocked valves shown herewith.

Fig. 1 gives a plan layout of the valve chamber (underground), which is situated at the front property line just outside the factory building. Six-inch service-connections from both mains enter the front of this chamber and by branches have connection with the fire service, the elevator supply and the drinking-water lines of the factory. The arrangement of valves and meters on these several branches is clearly evident from the sketch. The main valves on each line outside the branching point are interlocked. The sketch Fig. 2 shows the arrangement for this purpose. A round locking bar extends across the top of both valves and is so held in a guide frame of steel channels that by moving it horizontally it may be thrown across the top of either valve stem, thereby preventing that valve from opening. The length of the bar is such that when it leaves one valve stem free the other one must be down and have the locking bar over it, as the sketch clearly shows. The clearance between locking bar and valve stem is small enough to prevent any opening of the valve.

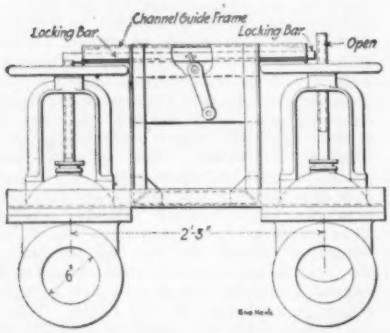


FIG. 2. INTERLOCK OF MAIN SUPPLY-LINE VALVES, BOSCH MAGNETO CO.'S FACTORY

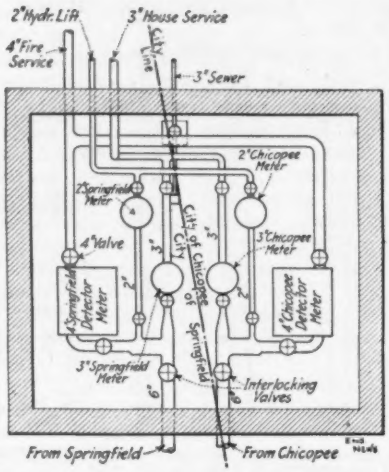


FIG. 1. PLAN OF VALVE CHAMBER; CITY WATER-SUPPLY CONNECTION OF BOSCH MAGNETO CO. FACTORY, SPRINGFIELD, MASS.

The arrangement is reported to be entirely satisfactory.

Annual Convention of the International Railway Fuel Association

The fourth annual convention was held at the Sherman Hotel, Chicago, on May 22 to 25, the chair being occupied by the President, T. Duff Smith (Grand Trunk Pacific Ry.). The first session was opened with prayer by Rev. F. E. Hopkins, and brief remarks by the president. An address by Robert Quayle, Superintendent of Motive Power and Machinery of the Chicago & Northwestern Ry., expressed the view that extravagance is a general characteristic of the present time and that in numerous directions there is necessity for economy. He reviewed the different methods in which economy may be insured in the use of railway fuel, including inspection of coal, proper design of locomotives, and the firing and handling of the engines while in service. He took exception to the view that the locomotive is an uneconomical form of power plant, and declared that in point of fact it is highly efficient and economical when the work done and the power developed are taken into account.

An address by Walter S. Bogle (Crescent Coal & Mining Co.) discussed fuel economy from the mining and coal-trade point of view, and also in regard to the question of conservation of natural resources. Laws in regard to safety appliances and compensation are putting heavy expense upon the mine owners, while there is little prospect of any increase in price to offset these expenses. As to methods of mining and coal getting, he stated that these are based upon the principle of getting the coal at the cheapest cost, and that in effect they are costly through the enormous proportion of waste. He estimated that in Illinois 50% of the coal is wasted, being left in the ground and practically beyond recovery. The election of officers resulted as follows: President, H. T. Bentley, Assistant Superintendent of Motive Power, C. & N. W. Ry.; Secretary D. B. Sebastian, Fuel Agent, C., R. I. & P. Ry., Chicago. The next meeting will be held at Chicago in 1913.

LOCOMOTIVE CAPACITY

A paper on "Fuel as a Factor in Locomotive Capacity" was read by Dr. Goss (Dean of the College of Engineering, University of Illinois), and we shall publish an abstract of this. It discussed the subject from two points of view: (1) adapting the fuel to the locomotive by sizing, sorting, washing, etc.; (2) adapting the locomotive to the ordinary and indifferent grades of fuel by special features of design in the firebox and engine. He suggested a firebox 20 to 25 ft. long, with a mechanical stoker on each side and fuel bunkers above the stokers instead of using a tender. In the brief discussion W. E. Symons (Chicago) approved of the idea of carrying the fuel on the engine, and instanced the Johnstone duplex (or articulated) compound tank engines built some years ago for the Mexican Central Ry. While these engines were not a success, Mr. Symons considered the general features of their design were correct. In Europe, tank engines are used extensively in road service, both for fast passenger and heavy freight trains. Mr. Symons was of the opinion that our locomotives have reached (and even exceeded) the limits of size for economical operation, but he admitted that the demand is still for increased power and size. He suggested again the old plan of building a system of trunk lines of 6 ft. gage, with heavier engines and larger cars, but we have pointed out the fallacy of the reasoning that such a change would effect ultimate economy (ENGINEERING NEWS, Dec. 7, 1911).

FUEL PERFORMANCE SHEETS FOR LOCOMOTIVES

A paper by Robert Collett (Superintendent of Locomotive Fuel Service; St. L. & S. F. R.R.) reviewed the results of an inquiry as to fuel sheets and described the system in force on his road. A monthly record is most generally used, and may be for individual engines or enginemen, both methods being used about equally. About a year ago the St. L. & S. F. R.R. introduced on a 250-mile division a daily performance sheet for in-

dividual engines, and this has now been introduced on all divisions. It shows the car-miles (passenger) or gross ton-miles (freight), the quantity of fuel, locomotive miles and hours of service. This is summarized every 15 days, and forms the basis of a monthly report. It is necessary to insure care and accuracy in all records, whether on the engine or at coaling stations. Inspections are made to check the overloading of tenders and waste of coal at the chutes, and deck guards are provided to prevent loss of coal from the gangways.

Proper Method of Firing Locomotives

This paper was illustrated in a most interesting manner by means of lantern slides and moving pictures. It was by D. C. Buell (Chief of the Educational Bureaus of the Union Pacific R.R. and Illinois Central R.R.), and related mainly to the work of the fireman. Apart from this, however, it showed that proper firing is only one step in fuel economy and outlined other steps of equal importance. These included some of the matters touched upon by other speakers, and we shall publish later an abstract of this part of the paper. In the discussion, Mr. Bentley suggested treatment of boiler water as an important step toward fuel economy, owing to the enormous reduction in heat-absorption due to scale on the tubes and sheets. Another speaker pointed out that a weak point in the policy of educating the firemen is that a large proportion of these men are only temporarily employed. In time of heavy business additional men are taken on, only a few of whom make good firemen, and just when these are beginning to understand the economic features of the work they are liable to be discharged owing to a reduction in business.

Anthracite Coal for Locomotives

The advantages and disadvantages of this fuel were presented in a paper by T. S. Lloyd (formerly Superintendent of Motive Power of the D., L. & W. R.R.), but he pointed out that the supply is too limited to permit of general use, even on passenger engines. The special feature of the paper, however, was to suggest the use of this fuel in and near cities as an offset to the demand for electrification which is largely based on the smoke nuisance of soft-coal locomotives. This would apply to regular trains and suburban service. For such urban use the author considered coke and oil to be less available, while briquettes have yet to show their efficiency, as compared with cheap coal, although briquettes made from anthracite culm have been used extensively and successfully. He considered it certain that ultimately they will be used on a large scale in locomotive service in this country. With anthracite used as suggested, the engines of outgoing trains would start with a supply sufficient to carry them beyond the city limits, while those of incoming trains would take a small supply at some convenient point. In the discussion, doubt was expressed as to the successful operation of such a system, as on many soft-coal engines the fireboxes are ill adapted to the use of anthracite, and the fireman would have trouble on his hands in making the change from one fuel to another without interfering with the proper working of the engine. We quote from the paper as follows:

> Freedom from smoke and cinders makes anthracite an ideal fuel, especially in the neighborhood of large cities. The small amount of gas from a few hard-coal burning locomotives is unobjectionable. The only questions are as to its adaptability to locomotives in present service and as to its cost. About half the locomotives causing smoke near a large city are in switching service. The draft on a yard engine is usually not heavy, and therefore the yard locomotives in present use could be adapted for anthracite by changing the grates only. The lower priced, small sizes can be successfully used.
>
> Of the freight and passenger engines, almost all now built have wide fireboxes with grate area sufficient to burn a mixture of anthracite and bituminous coal with full head of steam while in the city and suburbs. Such a mixture (properly fired) is practically smokeless. If the locomotives engaged in suburban, transfer, and yard work alone were arranged to consume anthracite fuel the abatement of the smoke nuisance would be practically secured as far as concerns locomotives. If the gases and more particularly smoke from locomotives using bituminous fuel are as destructive to property and goods in business houses as claimed, it should accentuate the importance of a trial of hard coal.

Locomotive Draft Arrangement in Relation to Fuel Consumption

This lengthy paper by H. B. MacFarland (Engineer of Tests, A., T. & S. F. Ry.) took the point of view that the draft and front-end arrangements of locomotives are adjusted mainly with a view to making the engine steam well rather than to effecting efficiency or economy in fuel consumption. The author described some of the special draft appliances that have been tried, and showed the results of tests made on a number of engines of his road. The conclusions presented are that the present system is very extravagant in fuel and water, and that the efficiency of the steam jet as a means of producing draft is extremely low from the standpoint of power. The loss in power of the engine due to the throttling effect of the exhaust is very great, and a material saving would be effected by the use of some means of creating the draft with equal mechanical efficiency and with the expenditure of power only equal to that required to draw the gases through the boiler. We shall publish some extracts from this paper.

In the discussion, Mr. Symons expressed the opinion that the adjustment of the draft appliances is but a secondary means of reducing the back pressure. The valve gear, valves and steam passages should be considered first, and the exhaust nozzle last. He advocated the four-cylinder balanced-compound type of locomotive and the adjustable exhaust nozzle. In Mallet engines having boilers of the combination type, with tubular feed-water heater and superheater between the boiler proper and the smoke-box, the conditions of draft are very different from those of engines having the conventional type of boiler. Mr. Quayle (C. & N. W. Ry.) remarked that the factors of air admission, fuel and traffic were as important as the exhaust appliances in relation to proper draft and fuel economy. Mr. Manchester (C., M. & St. P. Ry.) pointed out that while there are certain general principles, yet there are innumerable modifications and variable factors due to practical conditions; nevertheless, there are possibilities of material improvement in locomotive design and operation on the lines suggested by the paper. Mr. MacFarland referred to experiments with a fan for creating the draft independently of the exhaust.

Inspection of Fuel

This is one of the important factors in securing fuel economy and a joint paper was presented discussing the subject from the points of view of the producer and the consumer. For the former, J. E. Hitt set forth that the purchasing agent usually pays more attention to price than quality. Whether he purchases a low grade or a high grade of coal, inspection is necessary to insure that he gets as good a quality as he ordered, but railways give too little attention to this point. The only way to clean coal effectively by the removal of slate, etc., is by inspecting its production in the mine, for at mines having large output it is useless to attempt such cleaning after the coal has been raised to the surface. For the railway consumer, Glenn Warner (Fuel Inspector, C., H. & D. Ry.) stated that the inspection is left too often to the master mechanic, traveling engineman, engine crews and coal-dock men; they have usually no time for a special knowledge of such work, and have no responsibility. Their rejection of coal would simply block delivery and start a controversy with the coal company. In view of the importance of coal to the railway, and the large amount of money involved in its purchase, it should be inspected by an officer having special knowledge and endowed with authority. His work should begin with the mining of the coal, and include its loading and shipment.

The Engineering Graduate and the World

By Charles H. Benjamin*

A story is told of a student who consulted a jeweler concerning a design for a class seal or pin. He said:

"We would like to have the design show a graduate viewing the universe and we think the figure should occupy about three-fourths of the field and the universe the rest."

It is generally admitted that the ratio mentioned above is exaggerated and some writers have gone so far as to entirely eliminate the effective area of the graduate. Some rather caustic and far-reaching criticisms of the methods used in technical education have raised doubts in the minds of many people as to the desirability of such training. It is the purpose of this article to present some facts and some opinions which are illuminating and may serve to allay the fears of doubting parents and guardians.

A bulletin has just been issued by Purdue University showing the occupations of its graduates; the accompanying table summarizes the information concerning those in engineering. Out of a total of 3717 living graduates, 3552 were located, so that the list is practically a complete one. The schools other than engineering are omitted from the tabulation given here. Chemical engineering is also omitted since this school has been but recently established.

This table shows clearly that a large majority of Purdue graduates are directly engaged in technical and productive organizations more or less in line with the studies pursued at college. Similar bulletins from other technical institutions point to the same conclusion.

In search of still more definite and detailed information as to the standing of the technical graduate in the engineering world and his opportunities for advancement, the writer recently sent inquiries on these points to various employers of Purdue graduates and also to some of the graduates themselves.

The employers addressed were for the most part large corporations employing a considerable number of university men. So far, replies have been received from 18 companies and the answers are in most cases complete and comprehensive. Among these are letters from large railway companies, from a leading bridge company, and from some of the principal manufacturers of power-plant equipment, steam, gas and electric.

The first question asked concerned the attitude of the company toward the employment of technical graduates in general. The answers to this are all favorable, some of them emphatically so. A few quotations will show the general tenor of the replies:

(1) From the chief engineer of a leading railroad:

I am strongly in favor of the employment of graduates of technical colleges for responsible positions in this department.

(2) From the general superintendent of motive power of one of our principal railway systems:

I feel that the mathematical and scientific foundation obtained by men in technical colleges makes it desirable to have a certain per cent. of such men in our employ in line for promotion; promotion being dependent on the man in question.

(3) From the superintendent of a large electrical company:

Altogether we have had fully 25 years' experience with college graduates in our work and you will find them in all departments of the company. Some of them are occupying positions of great responsibility and have much to do in fixing its policies. This, of course, means that the company believes thoroughly in college training, otherwise it would not engage so many college men.

The next question asked was in reference to the advantages possessed by the graduate when compared with non-college man of similar caliber. It is the unanimous opinion of those who reply that the technical graduate is superior to the man of equal ability who has not had technical training, since he has a greater adaptability and more readiness in attacking new problems. A few of the answers read as follows:

(4) From a railroad superintendent:

I believe that the young man who comes to us with a technical education is just that much ahead of the young man who has to get it after entering the service, and the former has the very special advantage of having been instructed properly, whereas the young man who has to educate himself, does so under considerable disadvantage.

(5) From the chief engineer of a railroad:

I feel that such graduates possess great advantages as compared with men of similar caliber who have not had the technical training. I consider that this is due, not so much to the actual knowledge possessed by the graduate as to his ability to accept increased responsibilities as they are placed upon him.

(6) From the assistant manager of an electrical company:

It is our observation that technical men are generally able to go ahead more rapidly than nontechnical men on account of the training which their minds have received at college.

Inquiry was also made as to any deficiencies noted in college graduates which affect unfavorably their advancement in business; and suggestions as to possible remedies were asked for. The answers to these queries are very frank and decidedly interesting.

The deficiencies noted can be thus summarized:

Over estimate by the graduate of his own abilities.

Lack of practical experience.

Little knowledge of business methods and economies.

It is generally conceded that these are largely disadvantages incident to the sudden plunge from college into the new life and will disappear with experience. The remedy usually suggested is more practical experience obtained during vacations or after graduation.

The fact seems to be generally recognized that too much should not be expected of the graduate the first year and that he himself should be content to begin near the bottom.

A few more quotations will show the spirit of the replies:

(7) From the superintendent of an electrical company:

There is apt to be a feeling on the part of the graduate that after spending several years in study, he is capable of larger and better things than he is generally assigned at first.

There is considerable detail work and apparently petty practical work that he feels able to omit from his career and he wishes to start in on the big problems.

(8) From the engineer of a bridge company:

The question of advancement in our company which would mean considerable responsibility, as compared with the smaller companies, depends largely on the personality, executive ability and general character of the man.

A person may have exceptional ability from a technical standpoint and yet be unfit for a position which requires oversight of a large number of men, or judgment from the executive or business standpoint.

I can only suggest that men be advised to develop a pleasing personality, executive ability and ability to get along with and handle men.

(9) From the manager of an electrical manufacturing company:

My suggestion would be that technical students should, at the close of their sophomore year, work during vacation in some manufacturing or even mercantile establishment, in order that the reality and seriousness of their acts, or their failure to do the things necessary might be more firmly impressed on their minds.

A somewhat similar list of questions was sent to graduates of the university who have been out ten years or more and who are in positions of responsibility. Answers have thus far been received from 18 graduates, all of them occupying positions where they control other men.

Four of the 18 are railway superintendents, 2 are manufacturers, 7 managers or superintendents of works, 2 assistant managers, 1 sales engineer and 2 chief engineers.

These men were asked more particularly concerning Purdue graduates, their equipment, their general standing, their relative earnings and suggestions for betterment. The answers are practically unanimous in commendation of the university training and its general effect

*Dean of the schools of engineering and director of the engineering laboratories, Purdue University, Lafayette, Ind.

upon the men, there being but one doubter among the 18.

Emphasis is laid upon the fact that the college education furnishes a good basis of theory on which to build and that too much practical knowledge must not be expected of the new graduate.

It is further stated that in general the technical man has the advantage in adaptability and readiness; that his earning power for the first two years is no better and sometimes not as good as that of the shop-bred man, but that in subsequent years he will have a decided advantage.

One of the most interesting features of these replies from graduates of the university is the general demand for more "culture" work in technical colleges, especially in the line of spoken and written English. Few criticisms are made of the engineering training received at college, but the general inability of the average technical graduate to express himself fluently and correctly in writing or in speaking is a subject of comment.

One or two quotations will suffice to show the general spirit of the replies:

(10) We all realize that an engineer should be more than simply good in his particular line of work. His knowledge should cover generally all allied branches, and as his success is often due largely to his personality and his ability to mingle with his fellow engineers, it seems to me that more attention should be given to his qualification as a writer and speaker.

(11) I feel that it should not be a source of discouragement to the professors, if all or even a large majority of the graduates should not attain the honor of becoming captains of industry or inventors.

(12) As regards his earning capacity on first beginning work, I do not believe it is any better than that of the untrained man. His advantage comes, however, in his ability to take on work and to fit himself into the new conditions more quickly than the man who has not had the benefit of technical training and in this way his earning capacity goes up on a much steeper curve than that of the untrained man who plods along, building up his education as he goes.

(13) I believe that too much attention cannot be given, either prior to the college course or during it, to a thorough grounding in rhetoric and literature, which will enable the engineer to express his thoughts in a clear, concise and forcible manner.

(14) The technical graduate should not, in his first years of experience, look at the immediate financial returns, but should devote his efforts to securing experience regardless of the money he may receive in return for his services.

Because of his better future prospects, I think the technical graduate can better afford to cast aside the question of financial remuneration for a few years at the beginning, than can the nontechnical man.

We have thus briefly reviewed the opinions of those who employ technical graduates and of those who are themselves graduates, and may perhaps sum up the evidence in the following conclusions:

OCCUPATIONAL SUMMARY OF GRADUATES.

	Civil Engineering	Electrical Engineering	Mechanical Engineering
Banking	1	0	7
Bridge construction	31	4	3
Civic railways	21	42	4
Construction and contracting	112	13	37
Consulting work	19	9	8
Farming and farm products	12	10	17
Graduate students	5	3	5
Heat, light and power	8	57	20
In public service:			
United States	53	24	13
States	6	4	3
Cities	45	3	8
Other	10	2	2
Lawyers	1	8	5
Manufacturing:			
Motor	..	13	31
Railroad	..	3	23
Iron and steel	15	12	40
Other mechanical	4	14	126
Electrical	2	113	30
Miscellaneous	53	50	133
Mercantile work	17	45	74
Printing and writing	2	2	9
Real estate and insurance	6	2	3
Steam railroads	194	36	122
Teaching:			
College	20	28	52
High school	6	15	29
Telephone and telegraph	1	58	3
Miscellaneous	5	2	10
Not specified	10	206	13
Total	649	778	830

The graduate of a modern technical college finds himself well equipped in the theory of his profession and with a good scientific basis on which to build. He lacks practical experience, a knowledge of men, and the commercial instinct, and must expect for several years to be at a disadvantage on this account. If he realizes this and devotes himself to acquiring information and experience along these lines, rather than in trying to get more salary, he will in a couple of years overtake and pass his non-technical rival.

He will do this the more easily if, in his college course, he has applied himself to the fundamental sciences and avoided narrow specialization.

His failings are apt to be too great impatience of drudging and routine and an overestimate of his own importance. If he is worth saving, these faults will soon disappear.

The universities are furnishing today a better scientific and industrial training than ever before and university graduates are justifying themselves in industrial pursuits.

In the endeavor to make the scientific training all that it should be, the literary side of education has been too much neglected, and we frequently find the graduates of technical universities unable to express themselves properly either in writing or speaking.

A more hearty coöperation between the language and the engineering departments will remedy this difficulty and result in sending out men who cannot only do things but can also talk and write of them intelligently.

The majority of the employers consulted show a decided preference for technically trained men and this fact is ample justification for the scientific education.

Each graduate must remember as he leaves his university, that commencement is in reality what it is in name, and that the next year or two will mean but further education for his part in life.

A Gas-Producer Power Plant has recently been put into service on the Harriman estate, at Arden, N. Y., showing an interesting combination of features. The station supplies (1) mine power to the Stirling Iron & Railway Co., 12 miles distant, (2) current for lighting various buildings in the vicinity of the plant and (3) current for a great variety of purposes about the Harriman estate, such as heating and lighting, elevators, and an inclined cable road 3100 ft. long.

The plant is in an L-shaped building, the main portion being 180x55 ft., and containing the engine and transformer rooms and the office. The other portion is 100x46 ft., and contains the gas producers and coal pockets. The building is near the main line of the Erie R.R., and coal can be dumped from a siding above the coal pocket. The producer room has space for five 350-hp. bituminous suction porducers, only three of which are installed. The engine room is laid out for five 340-hp. gas engines, but only three are installed, directly connected to 250-kw., 2400-volt, three-phase, 60-cycle generators. In the auxiliary equipment there are, first, two 40-kw., 125-volt, d.-c. exciters directly connected to a three-cylinder, vertical, single-acting gas engine. Three motor-driven Root blowers maintain pressure in the gas main. One may be belted to a 15-hp. gasoline engine to be used in starting up the plant from cold condition. Two motor-driven, single-stage, 250-gal. turbine centrifugal pumps furnish circulating water and one of these can be belted to the gasoline engine for emergency service. One motor-driven, double-acting single-stage air compressor will deliver air at 200 lb. pressure and a second similar compressor is arranged to be belted to the gasoline engine. The compressors pump into three steel receiving tanks, one of which is ample for ordinary starting.

For the 12-mile transmission line the generator voltage is stepped up to 13,200 volts; 2400-volt feeders lead to the estate substation and to the local consumers near the power station. These lines run overhead with the exception of part of the estate feeders which are placed in conduits from the foot of the mountain on which the Harriman house is built. The estate substation is used entirely for the light and power supply of the main and surrounding buildings, and is located about 1000 ft. from the house. Besides the lights and small motors for pumps, refrigerators, etc., an 88-kw. water heater is used for the green house. In the substation are two motor-generator sets, each consisting of two 70-kw., 125-volt, direct-current generators (on a three-wire system) directly connected to a 2300-volt induction motor. Three transformers supply power to the cable hoist and to the motor of a storage-battery charging set. In the battery room there is a 1600-amp. hr. battery for the three-wire distribution lines. The distribution about the grounds from the substation is in iron conduits. Westinghouse, Church, Kerr & Co. were engineers for the equipment.

Crown of Paved Streets

By S. Whinery*

A statement of the purpose of street crown, and a suggestion for forming a slight ridge at the center to improve the transverse slopes. The road surface is to be shaped to two circular arcs, making an angle of about 2° at the center.

*Consulting Engineer, 95 Liberty St., New York City.

There has been a good deal said and written on the subject of the proper "crown" for paved streets, and a number of designs and formulas have been used, or devised and published. In the writer's opinion the matter does not call for fine-spun theories or for the application of complex mathematical formulas and details.

Engineers seldom take the time and pains to set accurate cross-grade stakes, and if they do it is hardly possible (with the ordinary methods of construction) to make the paved surface conform precisely thereto. Even if the pavement surface were originally constructed accurately to some theoretical curve it would not remain long in that condition; slight settlement, or wear under travel, would soon destroy its nice adjustment. It would seem, therefore, that all that is needed for practical purposes is a common-sense treatment based on sound principles, and reduced to easily applied rules or tables.

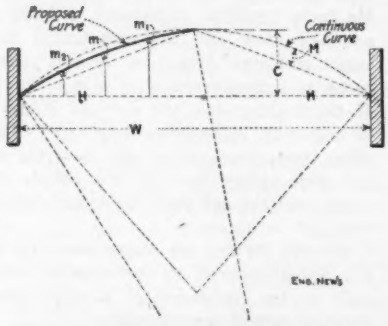
Considered from the utilitarian point of view we may say of the crowning of paved streets:

1. That its main purpose is to drain the water from the street surface to the gutters.
2. It is desirable that this drainage should be effected as promptly and completely as practicable.
3. But rapid and thorough drainage must not be secured by such steep cross-grades as might affect the safe use of the street. On the other hand enough inclination is desirable to produce currents, from rain or from flushing, sufficient to remove the finer dirt and dust and carry it to the gutters.

Were it not for the uneven distribution of travel, which is heaviest along the "quarter" of the street, the simplest and best model for a street surface would be the ordinary, plain roof, having the proper "pitch." To partly compensate for this more rapid wear along the quarter, a convex, curved surface has been generally used, the usual section adopted being an arc of a circle or parabola (which curves do not differ appreciably when applied to ordinary streets) from curb to curb, as shown by the dotted line in sketch herewith. If we let W = the width of the street between curbs, and C = the middle ordinate or "crown," both in feet, then the "rise" M of the half arc above the half chord is $\frac{1}{4}C$ at its middle point.

The objection to this continuous circular contour is that it results in quite a wide, comparatively flat surface at the middle of the street and a relatively steep slope or transverse grade near the curb.

To overcome this objection the writer proposes the use of a surface having the section of two comparatively flat circular arcs intersecting at a small angle in the middle of the street, as illustrated by the full lines in the sketch. The curves may be of such radii as to give any desired rise m above the half-chord at the quarter, m being less than M. In other words, the amount of crown and of convexity of the surface may be fixed independently of each other.



CROSS-SECTION OF PAVED STREET, SHOWING PROPOSED TWO-SEGMENT OUTLINE

(S. Whinery.)

Experience and observation have led the writer to adopt, for general use, a crown, $C = \frac{W}{60}$. The common custom of varying the degree of crowning with the different kinds of pavement seems unnecessary and illogical. For the value of m the writer suggests $m = \frac{W}{480}$, as being about right; this makes m just half of M, the quarter rise for the continuous circular curve. On a street 30 ft. wide between curbs the above ratios would give $C = 6$ in. and $m = \frac{3}{4}$ in.

Having the length of chord and height of the ordinate we may compute the radius of the circular arcs, but in practice this is unnecessary.

If intermediate ordinates, as m_1 and m_2, are wanted, to establish three equidistant grade points between the middle of the street and the curb, they will each be $\frac{3}{4}$ m, or $\frac{W}{640}$. These ratios are used in this article.

Since in practical work the length of the chords will not differ appreciably from that of the corresponding horizontal lines, and the lines m_1H, mH and m_2H may be considered as straight vertical lines, we may readily compute the elevation of each point in the surface above H, or below the crown level, and set grade stakes accordingly; or we may construct a table giving these elevations for streets of various widths.

If we compute these elevations in terms of W for a street of unit width ($W = 1$ ft.), we shall get the following factors:

		ft.	in.
Af crown, C	$= \frac{1}{60}$	0.016667	0.20000
At point	$m_1 = \frac{1}{60} \times \frac{3}{4} + \frac{1}{640}$	0.014063	0.16875
At point	$m = \frac{1}{60} \times \frac{1}{2} + \frac{1}{480}$	0.010417	0.12500
At point	$m_2 = \frac{1}{60} \times \frac{1}{4} + \frac{1}{640}$	0.005729	0.06875

These factors multiplied by the width of any street will give the proper elevations for the surface above the base line H.

The following table gives these elevations for a number of streets of common widths. The elevations are given in feet, as being more convenient for setting stakes with the level. For the ordinary method of setting stakes with Ts, inches are more convenient.

It might at first thought be feared that the intersection of the two curved surfaces in the middle of the street would present an objectionable or at least unsightly "comb" there, but computation will show that the angle between the tangents to the curves at that point is less than 2° and is constant for all widths of street. Such an angle would be quite imperceptible to the eye, espe-

TABLE FOR CROWNING STREETS

Elevations in feet above base-line = bottom of gutters

$C = \frac{W}{60}$ $m = \frac{W}{480}$ m_1 and $m_2 = \frac{W}{640}$

	Width of street between curbs, in feet						
	1	24	30	36	42	48	60
At crown C.....	0.0166667	0.400	0.500	0.600	0.700	0.800	1.000
At m_1.....	0.0140625	0.338	0.422	0.506	0.591	0.675	0.844
At m.....	0.0104167	0.250	0.313	0.375	0.438	0.500	0.625
At m_2.....	0.005729	0.137	0.172	0.206	0.241	0.275	0.344

cially after the top of the pavement becomes slightly worn down from its original contour.

The chief merit of this proposed section is that the cross-grade is less flat near the crown, and is not so steep near the gutters. Thus, on a street 30 ft. wide, crowned 6 in., having the usual circular section, the cross-grade at a point 4 ft. from the center of the street is 1.77% and at a point 4 ft. from the curb it is 4.91%, while with the proposed section the grades at the corresponding points will be respectively 2.24% and 3.8%.

The proper amount of crown to be used on paved streets is largely a matter of opinion, and it is quite likely that many engineers will not approve a crown based on the ratios to W used in this article. These ratios, both as to C and m, may be changed without abandoning the general design of two curves intersecting in the middle of the street, and tables for the work may be prepared accordingly.

It is the practice of some engineers to reduce the amount of crown proportionately to the gradient of the street. The utility of this is doubted by the writer except on excessive grades, but if it is desired to do so the proposed design can be readily and simply applied. Only the height of the crown C would be reduced (without affecting m), and this would proportionately reduce the elevations at the other points. Thus, if C were reduced from 6 in. to 4 in. on a street 30 ft. wide, only the vertical elements between the half-chord and the base line would be altered, and the proper correction could be subtracted, in most cases mentally, from the tabular elevations. In this case the corrected elevation at the quarter, which the table gives as 0.313 ft. = 3.76 in., would be

$$3.76 - \frac{6-4}{2} = 2.76 \text{ in.}$$

It often occurs that the gutters along a street are at different elevations. When this difference of elevation is less than $2C$ the simplest and best treatment is to shift the location of the crown to the proper distance from the middle of the street, toward the high side. If d = the difference in elevation of the gutters, and W and C represent the width and crown as before, then the distance of the crown from the higher curb will be (for the ratio of W: C here used);

$$\text{distance} = \tfrac{1}{2} W - 15d$$

and the two side slopes may each be treated as half a street of double the width, using the appropriate tabular elevations above the gutter on that side. If d is equal to $2C$, the slope will, of course, be wholly toward the lower side, and if greater than $2C$ such special treatment must be resorted to as may seem best for the conditions.

The "Excess Lime" Method of Disinfecting and Softening Water

What is, so far as we know, rightly described as a novel method of water treatment, in which lime is used "primarily as a germicidal agent and only secondarily and incidentally for softening purposes," has been made the subject of the Eighth Research Report of Dr. A. C. Houston, Director of Water Examination, Metropolitan Water Board (London). The actual title of the report is "The Softening, Purification and Sterilization of Water Supplies."

Briefly stated, the method described, which as yet has not passed beyond the experimental stage, consists in applying very large quantities of quicklime to water, letting the water stand long enough for the chemical to act and then removing the excess of lime by adding a considerable quantity of "untreated" water if the water supply in question is hard, or, if the water is soft, neutralizing the excess of lime by carbonic acid. All this is proposed by Dr. Houston as preliminary to filtration. Moreover, he proposes to use some means of disinfection for the water added to reduce the excess of lime.

The circumstances which led to the experiments of this novel method of water treatment are these: For a number of years past, Dr. Houston has become more and more convinced, as a result of varied and extensive studies, that the best and safest method of insuring the bacterial purity of the London water-supply is to place chief reliance upon what he terms the equalizing and devitalizing effect of water storage so as to produce a reasonably safe water bacterially, prior to filtration. The success of this plan depends upon being able to shut down the pumps when the water is of poor quality and to draw heavily upon the river when the water is relatively good. This in turn involves the provision of a large amount of storage and the utilization of that storage in such a way as will insure that all the water stored shall be retained for the necessary devitalizing period. The failure of Parliament in 1911 to authorize the full water-storage program of the Metropolitan Water Board prompted Dr. Houston to extend his studies of methods of treatment of water which should be supplementary to storage or make up deficiencies in times of bad water. The excess-lime treatment method was experimented with, having this end in view.

Before going further with a description of the excess-lime method, it may be stated that the report already mentioned contains some very interesting remarks and statistics on the economic value of water softening. The net conclusion to be drawn from the data given is that the saving of soap due to water softening is often grossly exaggerated in reports and articles dealing with the subject. This is largely due to the assumption that all the water softened is used with soap and that enough soap is used to produce a lather. This is, of course, far from being the case. Those interested in this particular subject will do well to consult the report mentioned.

Coming now to Dr. Houston's experiments, a more definite idea of the reason for undertaking them may be gained from the following quotation:

> Numerous experiments, fostered by recent events, have been carried out as regards the treatment of flood water, and the results of some of these investigations were dealt with in my Seventh Research Report.
>
> I am now able to report that a stage has been reached which, whilst it does not, perhaps, justify any specific recommendations being made, yet permits of my giving an impartial account of a singularly simple and apparently perfect method (apart from questions of cost, and as judged by laboratory standards) of overcoming all vitally important difficulties in connection with the purity of the Metropolitan Water Supply.
>
> The method referred to depends on the discovery of a new way of using lime ("excess lime" method) so as to obtain not only the softening and mechanical precipitating effects hitherto associated with the use of this substance, but also the sterilization of the major portion of whatever total volume of water is being dealt with.
>
> When 1 part of quicklime (about 75% CaO) is added to 5000 parts of raw Thames water about 0.007% free CaO is left in the mixture and this excess is sufficient to kill B. coli in from 5 to 24 hours. To neutralize the excess CaO, not less than 25% of stored water must subsequently be added.
>
> The greater the temporary hardness of a water, the larger obviously is the proportion of the whole which can be sterilized by this method. In all cases the proportion which cannot be sterilized is the amount which is required to neutralize the 0.007% of CaO. Less than 0.007% CaO is actually needed for bactericidal purposes (24 hours' contact), but in matters of this kind a margin of security should be allowed for.
>
> In the ordinary lime softening process the procedure, of course, is quite different. Quicklime or slaked lime is added to the total bulk of the water to be softened, and in amount purposely calculated to be rather less than is needed to combine with the bicarbonates present (i.e., just short of removing the whole of the temporary hardness). If on testing with phenol phthalein or silver nitrate solution, a pink or brown color develops with these two tests, respectively, this indicates an excess of lime, which is always to be carefully avoided. When such an event happens the dose of lime has either to be at once reduced or carbonic acid pumped into the water, to combine with the excess of free lime. Apart from the fact that the excess lime rehardens the water, it is not desirable to give the consumer lime-water to drink.

Altogether, 29 samples were subjected to the new method of treatment. It was found that the addition of quicklime containing about 75% of CaO to raw water

from the Thames at the rate of 1 lb. per 1000 Imp. or per 1200 U. S. gal. reduced the total hardness from 22.36 to 11.03, or a little over half. With 1.5 lb. to 1000 Imp. gal. (1.25 lb. to 1000 U. S. gal.) eight samples showed an average reduction of total hardness of from 23.82 to 8.42.

Dr. Houston states that he usually took "the death of B. coli in 10 c.c. of raw river water as indicative of the complete destruction of all the microbes of epidemic water-borne disease (typhoid bacillus and the cholera vibrio), but in some of the experiments 100 c.c. were taken." The "time factor" was found "to be of the utmost importance," the experiments showing that "a dose of lime which was quite ineffective in 1 hour was completely effective in 24 hours, and not uncommonly in 5 hours."

An important point to be noted is that the bacteria experimentcd with were "uncultivated." This "is the state in which bacilli are ingested by the water consumer." Experiments showed that larger quantities of lime would be required to kill "cultivated" bacteria.

The procedure with hard and with soft waters is thus succinctly stated in the report:

With hard waters it is a case of adding an excess of lime to the major proportion of the total volume, rendering the minor proportion "safe" by adequate storage, ozonization, chlorination, or other method, and mixing the two together so as to neutralize the excess of lime and render the whole perfectly innocuous. With soft waters, the procedure is to treat the whole bulk of water with an excess of lime and neutralize with carbonic acid, or sulphate of alumina or acid. The former operation incidentally involves "softening" and the latter may involve "hardening" the treated water.

The concluding portion of the report is reprinted, with omissions of purely local matter, as follows:

SUMMARY AT THIS STAGE

In summary at this stage I will assume that it is required to deal with 10,000 Imp. gal. of the Thames supply, to remove at least 15 parts of total hardness and to render the water innocuous.

(a) 15 lb. of quicklime, costing (b) three halfpence, would be added to (c) 7500 Imp. gal. of raw unstored Thames water. This would kill within 24 hours the B. coli and, inferentially, but certainly, the microbes also, of epidemic water-borne disease (e.g., the typhoid bacillus). The water would also be improved considerably, as judged by physical and chemical standards. The excess of lime (about 0.007%) would then have to be neutralized with (d) 2500 Imp. gal. of adequately stored water, which, according to all my experiments, would not contain any of the microbes of epidemic water-borne disease. Thus 75% of the water would be sterilized chemically, and the remaining 25% by nature's own method of sterilization (storage). The mixture would have lost about 15 parts of its total hardness and would contain no undesirable excess of free lime, besides being perfectly innocuous. Rapid filtration alone would then be required to remove the precipitate of inert carbonate of lime, and to bring the water up to a reasonable standard of chemical purity. If a less reduction of hardness were considered sufficient (say 10 instead of 15 parts), the figures (a) (b) (c) (d) would then become 10, 1, 5000 and 5000, respectively.

Let me give another illustration: Given a well water having over 15 parts of temporary hardness, which from one cause or another is considered to be potentially, if not actually, dangerous. Seventy-five per cent. of the whole would be lime sterilized, and the remaining 25% sterilized by means of ozone or heat or by active chlorine, and the two portions mixed together to produce a softened and also a bacteriologically safe drinking water.

The usual objection to ozone or heat is the cost in application, but here the cost would be reduced 75%; as only 25% of the whole volume would require this treatment.

The usual objection to active chlorine is the difficulty of sterilizing a water containing a variable amount of oxidizable matter without giving the water a faint taste, and of knowing how best to get rid of the slight excess of chlorine. Here, the dose being reduced 75%, any question of taste would be practically eliminated, and any slight excess of chlorine would be absorbed by the organic matter in the lime-treated water. I believe this to be a final solution of the vexed problem of how to deal with impure well waters, which, as a rule, are less amenable to storage and filtration processes of purification than river and surface waters. In cases where the water to be dealt with was not sufficiently hard, modifications of the above method would obviously be called for. For example, with impure soft waters, although much less lime would be required for germicidal purposes, the excess would have to be neutralized, preferably by carbonic acid, thus rendering them "harder"; unless the neutralization was so accurately carried out as to avoid the formation of bicarbonate of lime. In a word, it is possible and feasible to render hard and soft impure waters "safe," largely by softening the former and hardening the latter. This may seem a paradoxical statement, but it is fundamentally true.

DISADVANTAGES OF THE "EXCESS LIME METHOD"

The disadvantages of the "excess lime method" grafted on to an existing water purification plant are many and serious. The mere cost of lime to reduce the hardness even by ten parts would probably be about double the cost of the existing process of sand filtration.

The capital expenditure on the machinery and softening tanks would be very large, and the periodical removal and disposal of the sludge from the tanks would entail not only great expense, but might even be impracticable on a large scale. The existing sand filters might or might not be found well suited for removing the last traces of precipitated lime from the water. In this connection it should also be noted that although with filtered water the precipitate produced by the addition of lime may settle quite satisfactorily, the reverse is often true when raw river water is dealt with, especially if the colloidal and finely divided suspended matters are present in excess. The difference between raw and filtered river water in this respect is striking and practically very important.

Skilled supervision, labor charges, depreciation and interest on capital expenditure would also have to be considered most carefully.

ADVANTAGES OF THE "EXCESS LIME METHOD"

(1) It can be applied to 75% or any smaller proportion of the total supply.

(2) It is specially suitable for flood waters, because the water then is usually less hard, and the treatment has a clarifying and purifying action, apart from its bactericidal effect.

(3) The cost of lime treatment is not wholly unremunerative. Its advocates, indeed, claim a most substantial incidental gain on balance. I am content to say that against the cost of lime treatment must be set a certain saving of soap and fuel consumption and other advantages of a more or less debatable kind.

(4) But of first-rate importance, is its capacity quickly to render an initially foul water, absolutely safe, bacteriologically.

(5) It virtually increases the yield of the sources of supply by rendering them always fit for abstraction.

(6) It either postpones the construction of new storage reservoirs or prolongs the period of storage by bringing the lime-treated raw water into a parallel bacteriological condition with the adequately stored water. For example, taking the 75% basis merely for purposes of illustration, 75% of the total supply would be derived direct from the river and lime sterilized, 25% would be taken from the storage reservoirs and mixed with the 75% of raw water sterilized by the excess of lime. This would mean, in effect, prolonging the period of storage from 30 to about 120 days, or alternatively if the 30 days' storage is retained, postponing the construction of fresh reservoirs, assuming the existence of a sufficient reserve to cover periods of drought.

(7) It places the lime treated portion of water beyond the pale of epidemiological criticism.

(8) It is perfectly innocuous, no substance being left in the water which was not there initially in greater amount.

(9) Its complete fulfillment would raise the purity of the Metropolitan Water Supply to a pitch of perfection never before attained, if ever seriously contemplated as possible by any waterworks authority in the world, dealing with sources of supply comparable to those of London.

In conclusion, it may be said that if a case has been made out in favor of a reconsideration of the softening* problem it rests mainly on three grounds:

(1) The novel method of using lime primarily as a bactericidal agent, and only secondarily and incidentally for softening purposes.

(2) The safe and speedy utilization of flood water.

(3) The absolute elimination, so far as the portion of water treated with an excess of lime is concerned, of any danger from epidemic water-borne diseases (e.g., typhoid fever and cholera).

An Additional Water Supply for Toronto, Ont., together with reinforcements to the existing works, has been recommended by a commission of engineers appointed by the City Council in 1911. The commission included J. G. Sing, chairman; Willis Chipman, secretary; Isham Randolph, Chicago, and P. Aird Murray. An additional water supply would be taken through a new intake, the crib for which would be located some two miles from shore and seven miles from the Moreley Ave. sewage disposal works. The estimated cost of these works makes a total of $5,320,000 divided as follows:

Intake tunnel, 10,560 lineal ft., 10 ft. diameter		$ 633,600
Shore shaft, 160 ft. at $150 and lake shaft, 60 ft. at $150		33,000
Intake crib		500,000
Pump house site, retaining wall		80,000
Pump house		30,000
Pumping machinery, 60,000,000 Imp. gal. capacity (4 units, 15 each)		150,000
Transmission line, 8 miles		48,000
Rising mains, two 60-in. pipes, each 2,000 ft. long		80,000
Grading for and laying rising mains		20,000
Land for filtration works, reservoir, etc., 120 acres, at $600		72,000
Filtration works mechanical filter, capacity 60,000,000 Imp. gal. per day, machinery and laboratory		653,400
Covered reservoir, 130,000,000 Imp. gal. capacity		1,071,000
Gravity supply main from reservoir to high level pumping station, 55,000 ft. steel pipe (delivered)		880,000
Excavating for laying and covering at $5	$275,000	
Tunnel at Castle Frank, 1,200 ft. at $25 extra	30,000	
Crossing River Don, extra	15,000	
		320,000
Main from high level pumping station to West Toronto, 17,500 ft., 48-in., 42-in. and 36-in. (laid)		262,500
		$4,833,500
Ten per cent. for contingencies, engineering, etc		486,500
Total estimated cost		$5,320,000

In addition, the commission recommends the duplication of the filtration plant on the island in the lake at a cost of $1,130,000, the duplication of the water intake at a cost of $490,000 and installation of water meters at an estimated cost of $4,140,000. The use of hypochlorite for emergencies would be continued.

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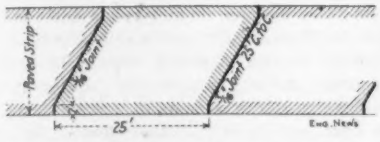
*The cost of quicklime is taken at one penny for 10 lb. (18.66s. per ton), and the lime used in my experiments contained a low percentage of CaO. The London County Council use at the sewage outfalls over 25,000 tons of lime per annum, costing 13.75s. per ton in 1910, and containing 95% CaO. [Ton = 2240 lb.—Ed.]

Letters to the Editor

Expansion Joints for Concrete Roadways

Sir—We are observing with considerable interest the behavior of the concrete pavements which are being used for the improvement of the various suburban thoroughfares in the vicinity of Detroit.

The matter of the proper expansion joint seems to be a moot point in connection with this class of work. We note that pavements laid two years ago are spalling quite noticeably at those joints which invariably run at right angles to the axis of the pavement.



PROPOSED EXPANSION JOINTS FOR CONCRETE ROADWAYS

We suggest an expansion joint to run at an angle with the traffic so that a 3-in. tire would "ride" over it. Inasmuch as a joint $\frac{1}{4}$ in. wide will allow for the expansion in 25-ft. lengths due to a change of 100° F., and the maximum difference would probably never reach 100° from the temperature at the time of setting, we would suggest a joint not over $\frac{1}{4}$ in. wide spaced 25 ft. apart at the angle shown in the accompanying figure.

ADAMS & CUMMINS,
Civil Engineers.

Detroit, Mich., May 6, 1912.

The Air-cooling Equipment of the Bosch Factory

Sir—I have read with considerable interest the description of the electrical and mechanical equipments of the new plant of the Bosch Magneto Co., at Springfield, Mass. It might be of interest to you to know that I was connected with this plant as consulting engineer on the air-cooling system which has been installed in the building, having designed the air-washing and fan systems which are at present installed. The scheme of cooling the building, which is rather novel in its way, was suggested by Mr. Klein, the chief engineer, and Mr. Wild, the superintendent, and carried out according to their ideas.

It remains to be seen whether the scheme will work out from a practical standpoint, as it will be noticed that the cool air is delivered into a large stair-tower, which has been kept tight, and the air is discharged through two large disk fans located at the roof. The general assumption would be that the air would flow along the line of least resistance, i.e., a great amount of it would pass through the top floor, a lesser amount through the third floor and so on decreasing until there was a very small amount running through the basement. The contention of the engineers of the company was that this could be regulated by the louver windows opening from the air shaft into the different floors, and it remains to be seen whether each room can be so arranged that it will take its proportion of fresh air.

The general scheme for laying out a building of this character would be to have a complete duct system for each floor so that the air could be distributed uniformly. If the scheme as laid out works satisfactorily, it will be a source of considerable saving on future installations of this character, as the elaborate duct system may be eliminated. I think that all those interested in this subject will, therefore, watch for the results which will be obtained during the coming summer.

I might say in connection with this plant that the air-washing apparatus has been so arranged that in case the cooling obtained with use of well water is not sufficient a refrigerating plant may be installed where the water may be reduced to a still lower temperature.

FRANK SUTTON.

80 Broadway, New York City,
May 20, 1912.

The Mud Nuisance on Oiled Macadam Roads

Sir—In your issue of Feb. 29 last, an editorial on the mud nuisance referred directly to California thus:

> It may be worth notice in this connection, apropos of the claim that the "bituminous-dirt" road is to be a low cost road, that in the southern California county which built a very large mileage of these oiled dirt roads several years ago the average cost was about $13,000 per mile, notwithstanding the proximity to the oil fields.

This must be based on misinformation or a misunderstanding and misconception of actual facts. The only county which has built a large mileage of oiled roads in a systematic way is Los Angeles, hence this statement must refer to that locality. A few years ago the county voted $3,500,000 of bonds for road building, but the proposed system is not yet completed. About three-quarters the total mileage (300+) is built, or under construction, and with the exception of 6½ miles all the first construction is *crushed-stone oil-macadam*. The stone is supposed to be 8 in. thick at the center and the cost averaged over $14,500 per mile; the New York Highway Commission can hardly get a lesson in oiled-dirt roads from the Los Angeles county system of construction—except in one way.

There was one piece of natural soil construction, the 6½ miles before referred to which was petrolithic, built in 1910. It extends along the foot of the mountains and was constructed of the soil as it lay—very sandy and gravelly but still a mere agricultural soil under cultivation. This was mixed with liquid asphalt, or oil, and tamped into a roadway: no stone was used, except such as lay in the soil. This road bears considerable hauling and auto traffic and is subjected to the wash of heavy mountain rains, yet it stands today acknowledged one of the best roads of Los Angeles county.

Monrovia, Calif., had about 30 miles of petrolithic streets; they were constructed of the native soil only—a granite mountainside gravel—mixed with California asphaltic oil. Their cost ranged from 25 to 40c. per sq.yd.; some of these have been in service six years carrying heavy trucking and auto traffic and have not yet required any repairs.

South Pasadena has several miles of "oiled-dirt" streets, which have been in service six to ten years. They were petrolithic and built at costs between 14 and 23c. per sq.yd. One of these, over nine years old, is said by the city engineer to be better today than ever and to have had little or no repair. Ventura, Calif., has over 13 miles of asphaltic macadam, built at an average of 58c. per sq.yd. and which have been used over three years. Some construction defects show, but the roadways cannot be equaled by streets anywhere that cost less than $1.

Santa Ana has several miles of petrolithic macadam streets which cost varying between 59c. and 67c. per sq.yd. and have been in use two and three years. Petrolithic macadam on North Grand Ave., Pasadena, has stood six years' use without repairs of any sort and remains in excellent condition today. Pasadena has a great mileage of asphaltic macadam ranging in thickness on different streets between 1 and 6 in., but all intended to be laid on a well compacted earth base; it has undergone heavy trucking and auto traffic intermingled and remains today almost free of repairs and in good

condition as high-grade pavement: some of the streets are five and six years old and have accumulated no repair cost. The automobile course at Santa Monica is over ordinary "oiled-dirt" streets and roads made from native soil and California asphaltic oil, at costs of from 14 to 20c. per sq.yd., with repairs to date of less than 1c. per sq.yd. The streets were not built for racing, but have not given way at a single point after three contests.

The mere oiled-surface road or the more developed petrolithic dirt type are not designed as high-grade pavements, but where a good grade of gravel is available to the extent seen in Monrovia these roadways pass into a higher class.

Such roads have shown so much value that engineers are hardly to be blamed for demanding proof of claims. But proofs exist and are increasing. At the same time, blunders have been abundant; grafters have passed cheap veneers on the reputation of good work; enthusiasts have wildly assumed this to be a universal low-cost roadway and the disillusionment has cost them, and others, dear.

Your statement about a "black greasy mud" on oiled roads would sound very queer to residents along any of the roads above mentioned. Out here we count no asphaltic roadway well built if the surface does not set and hold against dust and water as well as does sheet asphalt. We count no asphaltic oil fit for use which fails to produce this result.

These facts cannot be put aside on the ground that they relate only to southern California; the same construction has been tried elsewhere in wet and cold climates with the same results. We have known such roads to be held under water one and two months and come out practically perfect. We have known them to be frozen by temperatures below zero and show the same firm surface in the spring. A proper asphaltic oil has practically the same enduring qualities that asphalt has and will endure wherever asphalt will endure.

In South Bellingham, Wash., a petrolithic street was built four or more years ago. This is in a country where raining is the surest thing on the schedule. The soil is a black sticky bottomless muck, sometimes running slightly into clay and one which rolls up very badly on wagon wheels. About one mile of street was paved and constitutes the only paving in that part of the town. In winter when rains are worst, the other streets are reported as impassable for hauling and all the traffic is concentrated on this one. I have not seen this street in person, but it is reported to me as being still excellent and without any mud nuisance.

In Kansas City, an asphaltic oil roadway was built in 1909 during an unusually wet season, when it rained almost every day. The soil is reported as sticky clay; some stone was used. We do not consider this road properly built, as the superintendent sent out to direct it met conditions that were unfamiliar to him and he misjudged and mishandled them. This roadway utterly discouraged its makers in the beginning. Yet the effect after a little seasoning has caused several observers to ask us for information regarding petrolithic construction; there has been no complaint of any oil-mud or dust nuisance.

A petrolithic road near San Jose, Calif., has now stood five or six years of service, in a soil varying between a clay and a black mucky loam, which tracks badly in wet weather. This particular section is subject to heavy rains for six or more months and the surrounding country is sometimes under water for considerable stretches. The connecting roads are chiefly dirt. This road shows some easily repaired faults of construction in parts, but there has never been an oily mud or dust nuisance. From the train or auto it looks like asphalt.

The complaints which seem to be universal throughout the East seem to us to be distinctly due to improper asphaltic oils and improper use. As a roughly condensed statement, we may say that there are two classes of constituents in road oils and liquid asphalts now on the market — (1) those valuable as binding agents, and (2) those not valuable. The first includes not only chemically pure pitch, or asphaltum, but a number of other bituminous compounds which give just that proper flux essential to plasticity, "life" and bond. The second class is negligible or very injurious according to the proportions present in any particular oil.

The proved-out California oils, with which the successes above described have been secured, have an asphaltic and not a paraffin base; they are "topped," or refined, only enough to take off some unneeded light fractions and practically all their constituents are binding compounds. For instance, before me is a chemical analysis of a California liquid asphalt, showing 81.95% asphalt at 80° penetration and 77° F., DC standard; yet the total organic and inorganic matter insoluble in CCl_4 is only 0.25%.

Many road oils and liquid asphalts contain enough of paraffin constituents to impair the bonding powers of the pitch in them; some contain sufficient sulphur to work the same way; some contain a burned asphaltic residue which either prevents bonding or starts disintegration after the original "setting-up" process of oxidizing and hardening.

I do not wish to unreservedly commend all California asphalts or condemn all Eastern ones. We have seen bad ones among the first and good among the second. There are several excellent asphaltic macadam roads made with products of concerns east of the Rockies, but it has not been demonstrated that these asphalts retain their "life" indefinitely, like the best California oils, and that they retain indefinitely a similar re-workableness.

The effects of continued wet or dry weather, of mixed traffic, and of mud and dust carried onto a pavement from side roads are problems common to all types and grades of roadway construction. It is an error, involving a subtle and improper shifting of the burden of proof, to speak of these problems as though they related only to asphalt and asphaltic roadways. In all alike, trouble should be guarded against by protected approaches and regular cleaning; an asphaltic-oil roadway should be swept like an asphalt street.

Asphaltic-oil roadways are most susceptible to the disintegrating effect of dust and mud when the roadway is freshly made, and the builder should make careful provision if the danger is great. But still they do not show any of the greasy mud troubles referred to unless there is some unpardonable botch in the methods. Such a roadway has to pass through a certain "green" state in its beginning, during which the setting-up process is more rapid in hot weather than in cold, and in dry weather than in wet. During this seasoning the roadway needs guarding against dust and mud much more than after it has ripened into a perfect plastic asphalt paving under weather and traffic. But proper liquid asphalt properly handled should, at no stage after the road is opened to traffic, make an oily mud or dust nuisance.

It is of the utmost importance also to have, besides good materials, good construction — proper proportioning and uniform thorough compacting. These elements are often neglected as these elements involve skill and fine judgment. Good materials are more often present than the other two factors, though deficient in much earlier asphaltic work, when it was contended that mere oil and dirt would make a high-class roadway for heavy traffic. The proportioning is often right in the total mass, but wrong in many of the individual parts, as for instance when the asphalt calculated for 4 to 6 in. thickness of paving is concentrated into two. The most difficult element to secure seems to be uniform and thorough compacting. West Adams St., in Los Angeles, is a graded example. It was supposed to be a tamped construction. One end was moderately well tamped and shows up comparatively well after five years; the quality grades off steadily to the other end, where tamping was merely a pretense and the street was smooth rolled on top and passed as finished; this end went into ruts and holes immediately and these inevitably became pools of water and mud during the rainy season, though the oil itself still holds moderately well over the street. We objected to this construction, but nevertheless we still have to

hear this street, with other poor construction, cited as examples of petrolithic roadways. We cite this case as an example of what to avoid.

Miles of the earlier asphaltic macadam in the Los Angeles county good-roads system went to pieces because, among other things, of deficient compaction. The compaction by a road roller frequently averaged as much as 200 tons of stone per day, although 100 tons would be too high an average. It is not to be wondered that these roadways slipped and gave and rutted and had to be remodeled.

We are glad to give and receive all possible information on this subject. It needs free unprejudiced discussion and the comparison of more exact data.

K. F. POSTLE.

The Petrolithic Co., 345 Pacific Electric Bldg., Los Angeles, Calif.

May 1, 1912.

[There is certain knowledge that asphaltic oils will emulsify with water in the presence of colloidal materials like clay. The specific cases of freedom from mud, cited by Mr. Postle above, can be accounted for on the assumption that emulsification is prevented by the oxidation of near-pitch constituents in the California asphalts, together with the evaporation of dilutents and solvents, in the curing process which these liquid binders undergo after application.

Not all California asphalts give the complete freedom from mud nuisance shown in the examples cited by Mr. Postle. For instance, petrolithic pavement in Ventura City, Calif., one year after being laid, worked up into a greasy slush about a half inch deep on the streets receiving heaviest traffic. This was after a month of wet weither—a long period there. The streets which were little traveled developed no nuisance, and all of the streets dried up to the previous condition within a couple of days. The soil under and at each side of the roadways was a clay and the underground strata were filled with water. It is also reported that whenever a water pipe begins to leak underneath one of these pavements, in a few days the roadway will begin to churn up into a greasy mud in which the wheels will mire. The amount of mud noted in this city, it should be stated, is not to be compared with the eight inches of mire which has previously been encountered under similar weather conditions prior to laying the petrolithic pavement.

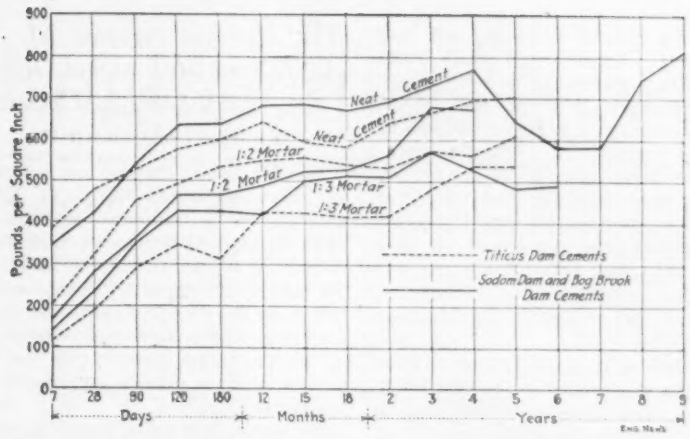
Mr. Postle believes that the presence of certain fluxes and impurities prevents complete "setting up" or brings on a later deterioration so that emulsification is never prevented. Comparatively simple laboratory studies should give exact knowledge on such points where now we have largely conjecture.—ED.]

Another Long Time Test on Cement Briquettes

Sir—In connection with the results of five-year tests on portland-cement briquettes which have recently appeared in your columns, the writer wishes to submit the results of a series of tests which he finds among his notes.

These tests were made in connection with the construction of the New York Aqueduct and the cement was used in the Sodom, Bog Brook and Titicus dams. The cement was Giant brand, manufactured by the American Cement Co.

The table and curves of the tests are shown herewith. The first series of tests represent average results obtained in testing 100,000 bbl. of cement used in the Titicus dam. The average fineness of this cement was 88.3% through the 100-mesh sieves. The second series are average results on 50,000 bbl. used in the Sodom and Bog Brook dams. The average fineness of this cement was 82% through the 100-mesh sieve.



LONG-TIME TESTS ON CEMENT, NEW YORK CITY AQUEDUCT

TENSILE TESTS ON PORTLAND CEMENT BRIQUETTES
(Made in connection with construction of New York Aqueduct)

		Days			Months						Years					
		1	7	28	3	6	9	12	15	18	2	3	4	5	6	7	8	9
Series No. 1. Cement used in Titicus dam.	Neat cement	157	380	476	529	575	599	642	504	584	641	668	699	704	647			
	1:2 mortar	...	200	317	450	491	532	549	557	541	536	573	565	610	631			
	1:3 mortar	...	115	185	280	347	311	426	424	416	419	483	539	540	611			
Series No. 2. Cement used in Sodom and Dog Brook dams.	Neat cement	140	348	422	540	634	638	682	687	672	694	736	771*	646	583	585	749	817
	1:2 mortar	...	166	280	364	468	468	490	526	530	564	680	674*					
	1:3 mortar	...	140	234	350	428	428	420	500	514	512	572	...*	486	491	618		

*Out of water for 9 months.

The writer has no further information as to the details of these tests with the exception of a note stating that the second series of briquettes were out of water for nine months between the fourth and fifth years. It is explained that this is the reason for the falling off in strength. Perhaps one of your readers can supply more information on these tests.

CLARENCE N. WILEY, Gen. Mgr.,
Atlantic & Gulf Portland Cement Co.
Ragland, Ala., May 15, 1912.

The Design of a Brick Chimney

Sir—Several features of the paper by J. Norman Jensen, "The Design of a Brick Chimney," in your issue of May 9, 1912, p. 866, are interesting, but it seems hardly possible that elements essential to a good design should have been omitted when thoroughness was plainly contemplated by the author.

In many classes of construction strength and durability are reached only through expenditures that have no intimate or direct relation to economy. In chimney design and construction this is not the fact. Economy in operation and permanence of structure are secured by the same means. The failure to recognize relations of this kind often leads through many formulas to inadequate results. The chimney shown cannot be classed with good chimneys and its appearance in your journal might be misleading.

An important object in chimney construction is to provide draft. This requires difference in temperature between the inside or flue gases and the atmosphere. Masonry walls readily transfer heat. The less the heat transferred the better the draft.

A thin masonry wall should not be subjected to a high temperature upon one side and a low temperature upon the opposite side, even if the wall is near the earth and well supported, instead of 125 ft. in the air, swayed by heavy winds,

jarred by electric discharges and badly supported. These simple facts should control in good practice in every locality. The full inside or double wall with its air space ensures a higher temperature for the products of combustion and a superior draft. Carried to the top this wall protects from the heat where protection is most needed and if properly built adds to the strength of the outer wall. Then there are no below zero temperatures on one side of a 9-in. or any thin wall and extremely high temperatures on the other.

The case is not as simple as it would be if any way existed to limit the difference in temperatures on the opposite sides of a single thin wall.

It will not do to say that good economy in the furnace requires only moderate temperatures in the chimney. The management may change. Quality of fuel may change. Inflammable material may accumulate and burn for hours in the flues or chimney itself. This may occur in the coldest weather.

Thompson says of concrete chimneys:

> It ought to be possible to lay and reinforce the concrete so as to prevent cracking even with the extremes of inside and outside temperatures.

Let us agree as an abstract proposition that this may be true. Does it follow that favorable and economical conditions should be disregarded or that a weaker design should be adopted?

Chimney construction at best is difficult work. Large cracks in concrete or fine cracks in brickwork should be avoided rather than invited.

M. Am. Soc. C. E.

New York, May 13, 1912.

Notes and Queries

Attention has been called to an error in the editorial "Accidental Electric Shock from Fixtures on Alternating-Current Circuits" wherein it was stated, on p. 896, that a committee representing the American Institute of Electrical Engineers, the Association of Edison Illuminating Companies, the National Electric Light Association, and the National Inspectors' Association, recommended to the Electrical Committee of the National Fire Protection Association that the National Electric Code make mandatory the grounding of secondary circuits of 250 volts and less.

The rule as formulated, accepted, and to be embodied in the next edition of the Code is appended to remove any doubt as to the approved provisions.

Transformer secondaries of distributing systems must be grounded, provided the maximum difference of potential between the grounded point and any other point in the circuit does not exceed 150 volts, and the following rules must be complied with:

When no neutral point or wire is accessible, one side of the secondary circuit must be grounded.

Where the maximum difference of potential between the grounded point and any other point in the circuit exceeds 150 volts, grounding may be permitted.

The Charges Against Mr. C. G. Elliott, late Chief of Drainage Investigations, Department of Agriculture

Sir—We believe that not one honorable engineer who knows Mr. C. G. Elliott personally or by reputation considers him guilty of anything beyond an indiscretion, committed for the purpose of furthering the public interests in his charge and to relieve an embarrassing position in which his branch of the department was placed by the withdrawal from it, by his superiors, of funds to make up a deficiency in another branch.

We believe that every honest engineer who is familiar with the charges against Mr. Elliott and the circumstances leading up to them, is convinced that these charges were trumped up by those who had reasons for getting him out of the way, which it would be detrimental to their interests to disclose. (See the letter of A. E. Morgan in Engineering News, of Mar. 28.)

We believe that Mr. Elliott is an honorable man, entitled to the confidence and support of every honorable man, and that the Congress of the United States should so declare him, thereby removing fully any doubt in the minds of his accusers as to whether they have shaken the confidence in which he is held by his fellow engineers and fellow citizens.

We think that nearly every reader of Engineering News would like to use his influence to this end, if shown how. If Engineering News will print the accompanying letter in convenient shape and suggest that each reader cut it out, sign and mail it to his Senator or his Congressman or to the President, the country will soon know where the engineering profession stands in this matter.

Respectfully,

A. L. Dabney, Memphis, Tenn.,
Jacob A. Harman, Peoria, Ill.,
Isham Randolph, Chicago, Ill.

May 1, 1912.

[We give space with pleasure to the above letter. The high standing in the engineering profession of the three signers of this letter is sufficient of itself to clear Mr. Elliott's reputation of any cloud. For the convenience of those of our readers who may wish to consult previous articles in Engineering News relating to this matter, we append a list below.

We may suggest, also, that where an engineer is willing to take the trouble, it will be preferable to copy the letter below or write a personal letter to Congressmen or Senators.—Ed.]

"Does the Punishment Fit the Crime?" (Editorial.) Feb. 22, 1912, p. 359.
"A Good Word for an Engineer." By H. B. Whitney, Mar. 7, 1912, p. 449.
"A Member of Congress, Jno. H. Small, on the Dismissal of Messrs. Elliott and Morehouse." Mar. 14, 1912, p. 494.
"More Concerning Mr. Elliott's Dismissal." By Arthur E. Morgan. Mar. 28, 1912, p. 601.
"The Engineering Plans for Draining the Florida Everglades." (Editorial.) Mar. 28, 1912, p. 604.
"Letter of the Illinois Society of Engineers and Surveyors." Apr. 4, 1912, p. 665.
"Resolutions Presented to the National Drainage Congress." By Isham Randolph. Apr. 25, 1912, p. 799.
"Wanted—A Chief of Drainage Investigations." (Editorial.) May 23, 1912, p. 996.

Sir:

The purpose of this letter is to urge you to use your full influence and efforts to the end that the Congress of the United States shall take decisive action to clear Mr. C. G. Elliott, late Chief of Drainage Investigations, Department of Agriculture, of the stigma that has been attempted to be placed upon his character. The undersigned is convinced that Mr. Elliott is an honest and honorable member of the engineering profession, a profession which is prompt to detect and ostracize one who shows traits of dishonor. I believe that the charges against Mr. Elliott are so frivolous and petty in their character, relating as they do to a mere matter of accounting, involving no loss to the Government, that the charges on their face reflect discredit on those who made them rather than on Mr. Elliott.

Respectfully,

_____

(Position or Business) _____

Address _____

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Engineering News

The Design of Small Dams

The excessive rainfall of the Spring and early Summer of 1912 has brought in its wake a series of disasters both large and small. The foremost among these, of course, are the floods which have laid waste so enormous an area in the Ohio and Mississippi Valleys. As a secondary result, however, we would call attention to the numerous failures of small dams throughout the country. We have not the statistics of these failures, nor do we think that complete statistics regarding them will ever be available, but we have before us some rather incomplete records of the failures during the past two months in one county of the State of New York, which show a surprising lack of strength in the small dams of that locality. As described on another page of this issue it will be noted that from Apr. 8 until May 20 there were in Essex County, N. Y., five dam failures aggregating in the total some hundreds of thousands of dollars' damage, though luckily no lives were lost.

The point we particularly wish to make in this connection is that, with possibly one exception, none of these dams was constructed under the direction of a competent engineer or with the exercise of any engineering talent. A large dam holding back many feet of water and extending across a broad river impresses the layman as a work of art needing the direction of competent authority, but somehow or other the minds which control the erection of these small power dams scattered throughout the country seem to consider the mechanical skill of the artisan all that is necessary for the construction of their smaller water-retaining structures. Absolute disregard for the necessity of stable foundations and for strength against sliding and overturning seems to mark nearly every one of the structures which failed in New York State in the last few months; in three cases at least, the error lay in the assumption that cobble stones, gravel and cement mixed regardless of theory or practice will form an artificial stone competent to stand the wear of ages and the pressure of many waters. A few more failures such as the ones we have described, involving in each case at least $50,000 worth of damage, should convince the owners of these dams that a structure holding back 10 or 15 ft. of water is not a plaything for the amateur, but requires the same careful study and supervision as a similar structure many times its size. If these owners cannot be convinced of this fact it is obvious that the people living downstream from the structures must have the protection of the state. When the life and property of its citizens can be safeguarded by knowledge which is fairly easy to obtain, it is criminal that such knowledge should not be applied.

A Question in Ethics for Engineers

The fact that no authoritative body in the United States has yet taken up the task of formulating a code of ethics for the engineering profession in general may justify us here in raising a question which not infrequently comes before the individual engineer for decision. Is it proper for an engineer to sign or approve a report, or make a recommendation, or prepare and sign plans, which are different from or even in opposition to his own convictions on the subject concerned?

We refer here not to the case of the engineer who is under the direction or jurisdiction of a superior engineering authority, although possibly our query could be applied even to this case. The more important case, however, and the one which under modern administrative and governmental conditions more frequently gives rise to uneasiness, is the case where an engineer is under the authority of a lay administrative officer. In such position the engineer is supposed to be the technical guide and adviser of his superior, or else he has a technical responsibility independent of his responsibility to his superior. When such a superior assumes to direct the recommendation or reported opinion of his engineering subordinate, is the latter justified in resisting such assumption, or is it proper for him to yield to the direction given and report or recommend as directed?

This is in no sense an abstract question. Cases can readily be cited, from the highest circles of our national government down to the smallest municipal administration in the country, or out of the affairs of many kinds of private corporations, to illustrate how this question arises and how in the ordinary working out of things it frequently leads to self-stultification on the part of the engineer and so in the long run exercises a debasing influence on the engineering profession. Further, the growing complexity of both governmental and corporation conditions makes the question have steadily increasing importance. On these grounds a seriously considered answer is needed.

Appropriations for Rivers and Harbors

In our issue of Apr. 4 in commenting on the pending river and harbor bill as reported by the House Committee, we remarked that the total expenditure provided for was $26,200,000 in round numbers.

A correspondent calls our attention to the fact that this total did not include the appropriation made for river and harbor work in the sundry civil appropriation bill under continuing contracts. Since our previous note was published, moreover, the Senate Committee has reported amendments to the House bill which increase the total appropriations by nearly $7,800,000. If the bill is passed in its present form, therefore, the United States will spend during the coming fiscal year over $46,168,000 on river and harbor improvements.

According to the report of Senator Nelson, Chairman of the Senate Committee on Rivers and Harbors, the total government appropriations for river and harbor work and works related thereto from the beginning of such expenditures up to June 30, 1911, is $693,914,000. This is the total amount which has been expended since the foundation of the government on these works of internal improvement. A simple operation in division shows that the amount proposed to be spent next year will be about one-fifteenth as great as the total expenditure during all the years since river and harbor work began. In view of the oft-repeated statement that the United States neglects its waterways and does nothing whatever for their improvement, it is worth while to put on record the actual fact, which is that there is no nation on the face of the earth which is expending anything like the amount for waterway improvement than is being spent in the United States.

Safety in Travel by Sea

The report of the Senate Committee which investigated the "Titanic" disaster was made public last week. The committee deserves due credit for its zeal and industry. The testimony taken before it amounts to over 1200 closely printed pages. Unquestionably, the committee undertook a large task to the best of its ability and has labored conscientiously to perform it; but as the old maxim reads, "a little knowledge is a dangerous thing." These eminent statesmen, starting in with a large ignorance of matters maritime, conscientiously investigated a single, great, overwhelming disaster. On the strength of what they have learned from this disaster alone they have drafted certain laws affecting the construction and operation of ships.

The verdict and recommendations of the committee will undoubtedly carry great weight with the public and with legislators. In the public prints the recommendations of the committee have generally been accepted as authoritative. But notwithstanding the unanimity with which the committee's recommendations have been accepted, it seems all the more the duty of such a technical journal as ENGINEERING NEWS to point out that this procedure is a very dangerous way to secure additional safety at sea.

Some weeks ago we pointed out that the Senate Committee was proceeding far astray in much of its work because of the lack of expert advice, which it could readily have had for the asking from the numerous naval officers in Washington. It is greatly to be regretted that such expert advice was not sought by the committee before rendering its report. We do not mean to say that all the conclusions reached by the committee are wrong. There are numerous matters on which its findings leave no room for criticism. There are others, however, in which to follow the recommendations the committee has laid down might lead us into paths of danger instead of safety.

Let us stop a moment and consider just what it is this committee has done. They have investigated a single great marine disaster; a disaster brought about by a cause which is among the most infrequent in the records of casualties at sea. After investigating every minute incident in connection with this great calamity, the committee proceeds to lay down rules to secure the safe construction and operation of ships, based on what it has learned with respect to this single disaster. In laying down these rules, it has paid no attention to all other causes of disaster at sea. This course has been entirely natural, for the committee began its work according to its own confession, with practically no knowledge concerning marine matters. But, as we have often pointed out in these columns, real progress toward safety can be made in no such way. It may be a quarter of a century or half a century before another passenger vessel will suffer by collision by an iceberg. Provision already made by the Navy Department for patrolling the seas to warn vessels of dangerous floating ice masses will in itself suffice to remove a great part of such danger as has hitherto existed. In the meantime, however, all the other usual and ordinary causes of marine disaster continue in full force. The men who have to bear the actual responsibility for lives and property at risk, the builders of ships and engines, the owners and operators of vessels, the masters in charge of them when at sea—all these must consider not alone the dangers of floating ice masses and of collisions, but all the sources from which disaster may come to a vessel and those aboard her.

The situation is exactly the same as it is in travel by land. Inventors and promoters and railway commissions and legislature are all the time bringing forward new schemes for increasing the safety of travel by rail. Some or many of these may have real merit; but before any of them can be safely adopted or even tried, it must be carefully studied by experts who are familiar with the whole field of railway operation. They must ascertain whether in guarding against one danger a dozen new and more serious ones will not be introduced. So in travel by sea, a scheme may appear to an eminent Congressman as particularly advantageous to secure additional safety at sea, whereas a marine expert, familiar with the whole field of vessel construction and operation can see at a glance that the device would introduce dangerous complication.

Even where a recommendation may be in itself unexceptionable, however, it does not follow that it would be the part of wisdom to adopt it. It may as well be frankly recognized that in travel by sea or by land, in the construction of buildings or in any other work undertaken by man, there is an economic limit to the amount which can be expended to secure safety. It has been many times pointed out that safety is always and everywhere a relative term. Absolute safety does not exist. Risk, greater or less, must be incurred in every occupation and at every moment of life, no matter how spent. While modern science and invention have introduced a multitude of new dangers into our daily living, they have at the same time provided many means of protection against these dangers, so that travel by sea or by land today is safer by far than at any previous time in the world's history.

We published recently statistics showing that the proportion of casualty in travel by water last year on vessels inspected under United States laws was only one passenger killed in over 800,000 carried. Suppose it were possible to reduce this rate of casualty by 50% by doubling the cost of construction and operation of vessels. The public would not stand for any such increase in transportation expense and the public would be right. Far more lives are sacrificed today because of economic pressure due to the high cost of the necessaries of life than are lost in all the casualties of travel.

In the construction of battleships, the hull is subdivided by longitudinal and transverse bulkheads and by the provision of a double-skinned hull, to an extent which could never be adopted in the merchant service. It could not be adopted in the merchant service because such a vessel would be so uncomfortable and unpleasant compared with the spacious decks of a modern transatlantic liner that the passengers would choose

the latter in preference. It could not be adopted for freight steamers because the cost of construction of such a vessel and the cost of its operation, with its enormous weight in proportion to its paying load would make such a vessel as absolute a commercial failure as was the "Great Eastern."

We call attention to these facts because we sincerely desire to see the public opinion, aroused by the loss of the "Titanic," yield some fruit in the way of real improvement in safety at sea. At present the aroused public opinion may lead to some of the extreme recommendations of the investigating committee being enacted into law and enforced for a few years. Then the whole matter will be forgotten and we shall fall back where we were before.

Take, for illustration, the committee's demand that sufficient lifeboats shall be carried by every passenger vessel to accommodate the entire ship's company. The fact that the "Titanic" had not boats enough to save all her passengers and crew is one on which the public has seized as of greatest importance. As a consequence, passenger vessels the world over are loading their upper decks with a large number of additional lifeboats. The owners and masters of these vessels are doing this because of pressure of public opinion; but so far as the actual safety of the ship's company is concerned, they know well that increase of safety by this additional provision of lifeboats is at best problematical.

The loss of the "Titanic" took place under abnormal conditions. There is not one day in a fortnight on the average in the North Atlantic, perhaps not one in a month, when boats could be launched and filled with passengers from a vessel of the size of the "Titanic" under the conditions which prevailed on that vessel, without a large loss of life. Lifeboats for the crew of a tramp steamer, used to a sea-faring life and exposure to hardships are one thing; but they are quite a different thing as a means of rescue for the many hundred men, women and children which crowd the decks of a modern transatlantic liner. It may be said that in times of fog, when collisions are most apt to occur, the sea is generally smooth so that lifeboats could be safely launched. This, however, is by no means always the case. Often a fog will cover the water while a heavy swell is running.

It is well recognized by sea-faring men that a lifeboat is merely a last hope when the vessel itself is doomed. Properly speaking, the lifeboat is not a "safety" appliance. It affords only a chance of saving life after all other hope has failed, but it is a chance at best and not seldom it proves a hopeless chance.

As we said above, in order to secure real safety, either at sea or on land, one must consider not a single source of danger but all the sources which are to be encountered. It may be useful at this time to recall another great object lesson as to the dangers of ocean navigation which at the time attracted almost as much attention as the loss of the "Titanic."

Twelve years ago this summer a fire broke out at the terminals of the North German Lloyd Steamship Co., in Hoboken, N. J. Most of our readers will remember many of the circumstances of that fire; they will recall how it spread until the great piers and steamship after steamship lying alongside them were all blazing fiercely; they will recall that the fire spread so rapidly that many of the crew on board these vessels were burned to death before they could escape from the interior; they will recall that vessels were set on fire before they could be hauled away from the pier by the swarm of tugs which were at the scene as soon as the fire broke out; they will remember that notwithstanding all the efforts of the fire-fighters, the tons of water poured on by the harbor and fire boats, by the fire engines on shore, the streams from the fire pumps on the piers and on the vessels themselves—that notwithstanding all these unusually favorable circumstances for fighting the flames, the conflagration raged fully half a day and resulted in the destruction of several of the finest steamships of the company's fleet.

While the Hoboken fire was the most spectacular example as to the dangers of fire on shipboard, object lessons as to this danger are occurring all the time. Only four days ago the Cunard Line steamer "Carmania," one of the finest vessels of the Cunard fleet, suffered serious damage by fire while lying at her dock in Liverpool. According to a cable dispatch on June 2 to the New York *Times*, the fire was fought by at least 20 lines of hose, manned by the entire available fire-fighting force of the city of Liverpool, including the fire boats in the harbor. The fire burned from 5 p.m. to nearly midnight, completely wrecking the upper decks of the vessel and the steerage, and doing serious damage, it is said, to the stoke hold and engine room. Only three years ago the Cunard Liner "Lucania," which fifteen years ago was one of the finest vessels afloat on the North Atlantic, was so seriously damaged by fire while lying at her pier in Liverpool that she was condemned and broken up.

The above are examples of fires on the highest class of ocean steamers; but fires on vessels of the ordinary class are occurring all the time. It is only a month or so ago that a coast-wise vessel from Baltimore to Boston, carrying a considerable number of passengers, had to be beached on the Long Island shore on her voyage north on account of a serious fire in one of her holds. A wireless call enabled the passengers to be taken off by a rescuing vessel before the necessity arose of putting them ashore; but all the efforts of the vessel's own fire-fighting force and of wrecking vessels brought to her assistance were unable to save the vessel itself.

Instances without number could be multiplied, all tending to show that the menace of fire as a danger to travel by sea is probably many times as great as any danger from floating ice. The bearing of this upon the present agitation and proposed legislation compelling the carrying of an enormous number of lifeboats ought to be sufficiently obvious. To cover the entire top deck of a vessel with a large number of boats, covered as they must be with heavy coats of paint, would furnish ideal conditions for the spread of a fire once started on any part of a vessel over its entire length.

It may be recalled that there were numerous suggestions in the newspapers, when the "Titanic" disaster was filling everyone's mind, that all ocean vessels should carry lifeboats propelled by gasoline engines. It was declared that nothing but the brutal disregard of human life had caused the steamship companies to adhere to the old-fashioned method of oars and sails as means of propulsion for lifeboats. Plenty of people at that time would have voted vociferously without doubt for a law to compel every steamship to be equipped with gasoline launches sufficient to accommodate the entire ship's company. But an expert who understands the relative importance of different dangers at sea would avoid shipping on such a vessel as he would avoid a pestilence.

It is bad enough to load the upper decks of a great vessel with fifty or more ordinary wooden lifeboats, all of them composed of highly inflammable material, but to scatter a lot of gasoline tanks in gasoline launches all over the upper decks, exposed as such tanks would be to heat from the sun and hot gases and air from the ventilating pipes of the vessel itself would be a direct invitation to disaster.

Another illustration of the care necessary in framing any requirements for safety in vessel construction or operation is the provisions of the bill introduced by Senator Smith, chairman of the committee, regarding the bulkhead division of vessels. According to press reports, the bill requires every steel steam vessel on the ocean or the Great Lakes to have an inner water-tight skin in the form of an inner bottom or of longitudinal water-tight bulkheads. It is not clear from this statement whether a central longitudinal bulkhead, such as was formerly installed in vessels, would be sufficient to fill the requirements. If so, it should be said that such a longitudinal bulkhead is now considered by most naval and marine architects to be rather a source of danger than of safety. If a transverse com-

partment is flooded on one side of the longitudinal central bulkhead and not on the other, it gives the ship a dangerous list which may bring her water line so low on the lower side as to cause the loss of the vessel when she might continue to float on an even keel.

Again, each vessel is required to be equipped with two electric searchlights. It is at least open to debate as to whether the use of such searchlights by a vessel on the high seas would be a source of greater safety or danger. Suppose they were used habitually at night to illuminate the path of the vessel for a long distance ahead. Watchers on the bridge and in the crow's nest would naturally follow the path of the beam of light. Their eyes would thus become unable to discern anything in the surrounding darkness. It might happen as a result of this that a sailing vessel would drift across the course of the vessel from the darkness on either side of the searchlight beams before she would be discovered by the men in the lookout.

Of course, arguments may be brought in answer to this, and it may be true that such searchlights might prove a real aid to safe navigation. The point we wish to emphasize is that their desirability or nondesirability ought not to rest on the opinions of a committee made up of senators or congressmen wholly ignorant of maritime matters. It is a matter for careful expert investigation as to whether such searchlights would be on the whole an advantage or detriment to safe navigation.

Again, there is the matter of furnishing binocular glasses to the men in the crow's nest. The newspapers heralded in flaming head lines a month ago the declaration that the loss of the "Titanic" could be directly traced to the parsimony which refused a $25 pair of marine glasses to the sailors in the crow's nest. There is good reason to believe, however, that to allow the lookout men the use of such glasses would contribute more to danger than to safety. Every engineer familiar with the use of telescopes and binoculars knows that their steady use unfits the eyes for ordinary vision for several minutes afterward. While it is proper enough for the officers on the bridge to have such glasses, as they always do, there are many vessel owners and navigators, we doubt not, who would hesitate to place such glasses in the hands of the men in the crow's nest.

Senator Smith's report ought not to be passed by, moreover, without a word of praise for the officers and crew of the "Titanic" for their general conduct in the hour of peril. He blames the general officers for not sounding a general alarm as soon as they knew the serious condition of the ship. Rather they should be praised for their steady nerve and sound judgment in quieting, so far as possible, all alarm and excitement. It needs but the slightest knowledge of human nature to realize that had a general alarm been sounded throughout the doomed vessel, had all the crew and the passengers from the first cabin to the steerage been told that the ship was doomed, there would have ensued a panic which the officers themselves would have been powerless to stay. In such a panic, in all probability, all order and discipline would have been destroyed. There would have been a mad fight of the strongest to secure the lifeboats. The probability is that in the confusion and rout of such a panic, no more than a mere handful could have escaped from the doomed vessel.

Undoubtedly the chief officers and a large proportion of their subordinates realized while the boats were being lowered that death stared most of the ship's company in the face. Too much praise cannot be given to these nameless heroes in the engine room, in the stoke hold and on the decks, who steadily carried out orders, and stayed in the place where duty took them with no thought for their own safety.

We forbear to take further space for further detailed criticism of the Senate Committee's report. As we have stated above, many of the facts pointed out in it are well established and proper to be put on record and the committee deserves credit for its zeal and good intentions. The greatest lesson to be drawn from it, however, is not found in its detailed recommendations, but in the object lesson it affords that real advance in safety can only be gained by the aid of expert investigation and expert advice. No engineering problem can be correctly solved with only a partial knowledge of the governing facts, and the problem of safety is first and last an engineering problem.

The International Navigation Congress

Continuing from our last issue the account of the meeting of the 12th International Navigation Congress at Philadelphia, the first technical sessions of the Congress were held on Thursday afternoon, May 23. Section I, devoted to Inland Navigation, was presided over by John Bogart; Section II, devoted to Ocean Navigation, was presided over by E. L. Corthell.

It is not our purpose here, however, to review at length in this place the technical proceedings further than to explain in a general way how the work of the Congress is carried on.

In the first place the governing body of the Congress, the so called "Permanent Commission," decides a long time in advance what subjects shall be considered at the next meeting. It then invites papers on these subjects from leading engineers the world over in each branch to which the subject relates. These papers when received are translated into different languages and printed, there being separate editions of the Congress proceedings in French, German and English. Then all the papers on a given subject are delivered to a "general reporter," who is some engineer selected usually because of his broad familiarity with the subject. It is his task to prepare a general summary of all the papers laid before him and finally to formulate certain general conclusions upon the subject.

All the papers and the summaries made by the general reporters are placed in the hands of the members months before the Congress opens. When it does assemble, no time is spent in reading the papers themselves, nor even the summaries prepared by the general reporters. Instead the several questions are at once taken up and on each question conclusions submitted upon the subject by the general reporter are offered for adoption by the Section. Discussion then takes place over these conclusions, the extent to which they are well founded and truly represent the best practice of the day.

This would all be simple and easily carried out if the Congress members all spoke and understood a common language; but, of course, many of them know only their mother tongue, or at best one other language. It is the usual practice therefore to repeat each speaker's remarks, as soon as he is finished, in one or two other languages. For instance, a member speaks on the pending question in the German tongue. As soon as he takes his seat, the Secretaries of the Section give a summary of what he has said, one rendering the speech in French, another in English.

Of course this procedure, with all that can be done in the way of abbreviation, more than doubles the time necessary to transact a given amount of business and makes the proceedings rather dull and slow to most of those in attendance, since much of the time they cannot understand what is being said.

Until the dream of a universal language is realized, however, there seems to be no better way to carry on a meeting in which nations speaking divers languages participate.

The technical sessions of the Congress occupied the afternoon of Thursday, May 23. At 5 p.m. the visitors at the Congress were taken in automobiles to the Philadelphia Commercial Museum. Here a special exhibit had been arranged including models of the Panama Canal and of the Panama locks and dams. There were also elaborate models showing the New York State Barge Canal and the plan for the radical improvement of the

Delaware River water front in the city of Philadelphia. In the evening the delegates were entertained by a theater party.

On Friday, May 24, the delegates were divided into two parties for all-day excursions. One of these was taken over the Reading R.R. to Bethlehem and was entertained at the Bethlehem Steel Works. The other and larger excursion, in which some 300 members participated, went by the Pennsylvania R.R. to Trenton, where they were taken on a short excursion through the city by a committee of citizens headed by the Mayor. The trip terminated at the New Jersey State House, where the visitors were welcomed in the assembly chamber by Gov. Woodrow Wilson. Special electric cars then conveyed the visitors to the steamer landing, where a boat was taken for a trip down the Delaware River to Philadelphia. This section of the river was especially interesting to the delegates, as it is this stretch from Bordentown to Philadelphia which it is proposed to enlarge and deepen so as to give a channel of 25 ft. depth and 100 ft. width at lowest low water. This work would form one important link of the proposed ship canal from New York to Philadelphia across New Jersey.

Arriving at Philadelphia in the early afternoon the visitors were escorted through the Cramp ship yard, the yard of the New York Shipbuilding Co. and finally the League Island Navy Yard, where the battleship "Connecticut" was inspected in dry dock. The visitors were then landed at Washington Park, an amusement resort on the New Jersey side of the river, where they were treated to a planked-shad dinner.

On Saturday, May 25, the Congress continued its work, holding technical sessions both morning and afternoon. A smoker was given at the Bellevue-Stratford Hotel in the evening. The following day, Sunday, two excursions were enjoyed, the one to Cape May and the other to Atlantic City. Visitors to Cape May inspected the large and expensive harbor which the government is constructing at this point and returned to Philadelphia by steamer up the Delaware River. On Monday the Congress continued its work with sessions morning and afternoon and in the evening the visitors were entertained at one of the largest and most elegant banquets ever given in Philadelphia. The great ball room of the Bellevue-Stratford Hotel was lavishly decorated with flags of all nations, and the list of guests, aside from the delegates, included a large number of prominent citizens of Philadelphia. Mayor Blankenberg presided as toast master and again showed his versatility as a linguist in extending welcome to the delegates from many countries.

The following day, Tuesday, concluded the sessions in Philadelphia. A large proportion of the delegates were taken on an excursion to Harrisburg, Washington and Pittsburgh, leaving Philadelphia at midnight on Tuesday.

Monday, June 3, was New Jersey day, in which the delegates were shown some of the work on the proposed New York and New Jersey ship canal and the work in waterway and water-terminal improvements on which the State of New Jersey is now engaged. Monday evening the delegates were entertained in New York City by a reception at the house of the American Society of Civil Engineers. On Tuesday the City of New York acted as host and the visitors spent the day on one of the municipal ferry-boats, being taken down to the Narrows and then along the Brooklyn waterfront up the East River, over the site of the proposed channel improvement, planned by Colonel Black, of the Corps of Engineers, involving an expenditure of $32,000,000; then back down the river under the East River bridges and around the Battery to the North River and along the entire North River waterfront, thus giving the foreign delegates an excellent opportunity to examine the commercial developments along a large part of the entire water front of New York harbor.

On Tuesday evening a party of about 150 of the delegates left by the steamer "Commonwealth" for an excursion to the Cape Cod ship canal and Boston. Others spent Wednesday in the examination of various great engineering works in progress in New York City and were to leave on Thursday morning for an excursion up the Hudson River by the Albany Day Line steamer "Albany" and then by the New York Central to Buffalo and Niagara Falls, following which an excursion is to be taken through the Lakes with an extension by members so desiring through the principal waterways of Canada.

A 2400-hp. Stumpf Engine of the mid-cylinder exhaust type has been in use since February, 1912, at the Rombacher Iron Works, Germany. This is the most powerful unit of this type ever built. The cylinder diameter is 1080 mm. (43 in.), and the stroke 1300 mm. (52 in.). The engine runs at 120 r.p.m., a notably high speed for this type, giving a piston speed of 17.2 ft. per second.

The regulation is exceptionally exact. No appreciable drop in speed can be detected even with the highest loads, nor can any over-speeding be discovered when the load is suddenly removed. The engine is used to drive a 600 mm. (24 in.) rolling mill. It is coupled directly to the rolling-mill shaft and has a flywheel weighing 70 tons.

The Stumpf engine is particularly suited to rolling-mill work because of its uniform steam consumption over a wide range of loading. It is claimed to be much more economical than a compound engine in consumption of steam. Due to its simplicity, it requires very little attention and consumes less lubricating oil than other engines.—"Stahl und Eisen."

National Conference on City Planning

The fourth American Conference on City Planning was held at Boston, May 27 to 29. About 125 members and delegates were present. These came from all parts of the United States and Canada, including St. John, Ottawa, Toronto and Alberta in Canada, Tacoma, Los Angeles, Santa Barbara, Kansas City and many larger and smaller cities in the United States. Architects, both landscape and building, engineers, members of city-planning commissions and other municipal boards and representatives of civic and commercial organizations were in attendance. Engineers took a notable part in the proceedings.

With the exception of one "free-for-all" session, at which many subjects were discussed, the program was marked by having a few set papers, pertaining to a small number of main subjects. By this means the program was not overcrowded and there was plenty of time, in most instances, for discussion.

The Conference opened on Monday with a lunch tendered by Mayor John F. Fitzgerald, of Boston, at which he and others spoke. Immediately afterward, automobiles were provided to enable the members of the Conference to see Boston, its suburbs and various municipal and metropolitan parkways, also the city-planning material at Harvard University.

The Meaning and Progress of City Planning

The first of the papers on this topic was presented by Frederick Law Olmsted, of Brookline, Mass. While nearly all cities have at least nominal control of new streets, this control usually amounts to but little more than rendering service as surveyors, draftsmen and clerks for private street openings. Efforts out of the ordinary are generally spasmodic and poorly controlled, so little progress is made. There are a few others, aggressive city-planning bureaus, but most of these do not grasp the principles involved and act on formal real estate lines. Parks are also acquired approximately, although as a rule parks are handled better than streets. Money for their improvement does not come so readily for parks as for streets, since parks are not so closely related to real estate interests. There is great need for coöperation between different municipal departments having to do with city planning, and for stimulation of some of them.

The general subject of the evening was continued by A. W. Brunner, of New York City, who opened his remarks by stating that the first popular impression to be overcome is that if city planning was undertaken, the work would be turned over to a number of artists to make the city "beautiful." Fear is also

aroused that the city will be bankrupted, industry hampered and old landmarks destroyed. These are all imaginary dangers. The author believed that the city plan should be the work of several men, each an expert in a special line, all working together. City planning is not work for amateurs.

The necessity for coöperation on the part of many masters of their several specialties was also urged by Prof. Geo. F. Swain, of Cambridge, Mass. Although city planning involves urban transportation, railway terminals, water supply, sewerage, and other engineering works, the engineer is not yet prominently identified with city planning. Whether this is due to the lack of initiative on the part of the engineer or to lack of appreciation by the public the speaker would not attempt to say, further than it might be the latter, and that the engineer was largely left out of consideration in the calls for the first conference. [He has since won or been tendered much recognition.—ED.] City planning will never be a success without the aid of the transportation and the municipal engineer.

Considerable general discussion followed the delivery of these three addresses. Mr. Olmsted, speaking again, remarked that the tables had been turned on him and that he had been appointed a member of town improvement commission for Brookline—to advise on general problems referred to the commission by the selectmen, rather than to go into city planning. The selectmen and the town engineer alike are too crowded by their numerous immediate duties to take up broad new problems and look for added trouble. T. R. Morse, of Tacoma, told of the municipal advisory board in that city, consisting of 21 members, including three engineers, three architects, etc. The board considers city planning, transportation and other public-utility problems and harbor facilities.

PAYING THE BILLS FOR CITY IMPROVEMENT

Nelson P. Lewis, of New York City, won the particular approval of the conference by an able plea for meeting the cost of all city improvements which increase land values, through no act of land owners, by assessing the cost on the property benefited. His paper will appear in a later issue of ENGINEERING NEWS.

James A. Gallivan, Street Commissioner of Boston, reviewed the experience of his city with special assessments and showed how real estate owners had succeeded through legislative action and otherwise in shifting nearly the whole burden of street improvements onto the general tax levy, at the same time calling up an enormous bonded indebtedness, hampering improvements, and bringing wealth to the owners of real estate. In a recent case only 8% of the cost of a boulevard had been assessed for benefits, yet the property owners tried to get the legislature to relieve them of part of this. The speaker believes that city authorities should be given a free hand in distributing the cost of street improvements.

A constitutional amendment permitting excess condemnation legislation in Massachusetts was approved by the people at the last election. Mr. Gallivan seemed to think excess condemnation a doubtful expedient in Boston. He cited figures to show how poorly it would work, in his opinion, in the case of the proposed street widening between the two terminal railway stations in Boston. An example of a minor improvement was given where the method seemed applicable. Several speakers came promptly to the defense of excess condemnation.

CITY-PLANNING STUDIES

Under this general head, J. R. Coolidge, Jr., of Brookline, Mass., read a suggestive paper on "Blighted Districts," or sections where land values are stationary or declining. He suggested that the causes of such blights be studied to the end that remedies may be applied. For instance, should it be found that an elevated railway has lowered the value of adjacent property, a parallel street may be improved and asphalted. The main point made, was that the duty of a city to so amend the city plan from time to time as to make property appreciate rather than depreciate.

Lawson Purdy, of New York City, heartily approved the philosophy of the paper. Stationary or declining land values indicate that the city is somehow at fault. Land at the center of a city should be greatest value and should never decline. The decline of real estate values west of downtown Broadway, New York City, is due to poor city planning, a lack of through streets of adequate capacity.

The second paper at this session was "The Public Street Systems of the Cities and Towns about Boston, In Relation to Private Street Schedules," by Arthur W. Shurtleff, of Boston. The author showed by lantern slides how the conveyance of traffic to Boston as a center had built up a notable system of radial streets, while the streets in other directions were disjointed and through passage necessarily roundabout because there had originally been no incentive for ready communication between the several rings of towns, and thus property owners had laid out their property at their own sweet will since the early radial routes were established. It would, however, be very easy to establish ring streets, if only intercommunity interest and coöperation could be aroused. This seems to be sadly lacking. The legislature has just killed the bill for carrying out the metropolitan plan recommended by a commission which reported on Jan. 1, 1912.

Mr. Shurtleff's paper was supplemented by three others, by Messrs. Larned, Rogers and French, engineers of Watertown, Newton and Brookline, respectively. These papers took up local conditions.

THE ZONING SYSTEM OF GERMANY APPLIED TO THE UNITED STATES—This was a formal paper on the program. It was by B. A. Halderman, assistant engineer in charge of city planning, Bureau of Surveys, Philadelphia. The zone system was explained as being more properly a district than a zone system, since restricting the character of houses and of industries by true zones would result in a general mix up as the city spread outward. The principle of the system was heartily approved by the author, the interests of the many being above those of the few whose "property rights" might be adversely affected. While the application of the zone system would be surrounded with difficulties peculiar to our municipal conditions, an aroused public opinion and recent improvements in the character of our city government give reason to believe that these obstacles might be overcome.

GENERAL BUSINESS

It was decided to continue the present informal conference plan of organization, in general charge of a large committee. F. L. Olmsted, of Brookline, was re-elected Chairman; Nelson P. Lewis, of New York, Vice-Chairman, and Flavel Shurtleff, 19 Congress St., Boston, Secretary of the Executive Committee.

Resolutions were adopted indorsing the general principle of meeting the cost of city improvements by assessing benefits on abutting property, as advanced by Mr. Lewis, and providing for studies of a city plan for a city of 500,000 people, the studies to be submitted to the 1913 conference for discussion.

Coal Oil for Fire Extinguishing is described as follows by a correspondent of the National Fire Protection Association "Quarterly":

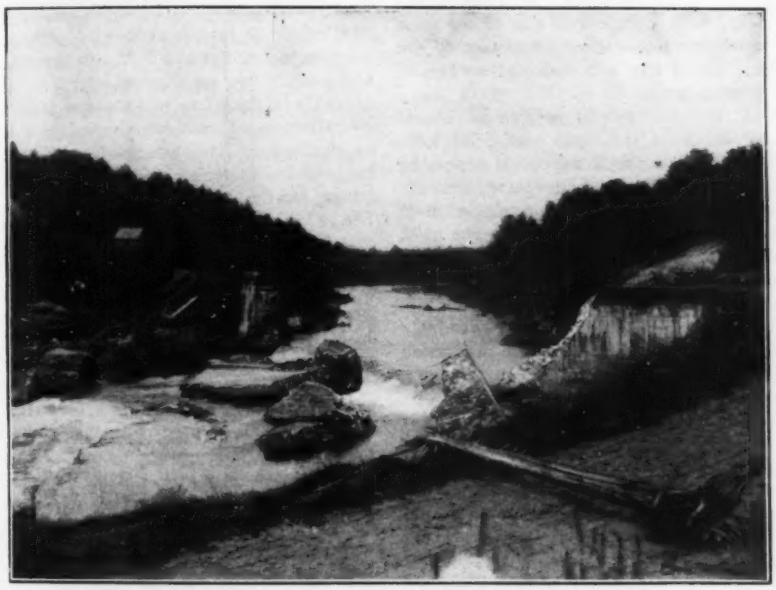
It is a well known fact that a bale of ginned cotton is packed and wrapped so tightly that casks of water and chemical extinguishers are of no avail in extinguishing a fire once it has eaten its way into the bale. In fact, a bale may be submerged in water with very little effect. It usually becomes necessary to pick it to pieces.

Lint cotton will only absorb water for a few inches from the outer surface of the bale. The fire, however, usually penetrates to the center and is industriously working its way in several different directions therefrom when first discovered. At this stage and at this stage only, coal oil is said to be the only known agent that will penetrate to the seat of the trouble. When poured into the slightest crevice of the bale it is slowly but surely absorbed by the lint cotton contained therein. After reaching the fire itself it will, if carefully and persistently applied, finally smother it.

This result is said to be accomplished without greatly impairing the commercial value of the unburned portion of the bale.

Failure of the Lincoln Pond Dam near Westport, N. Y.

The spring and early summer season of 1912 has been particularly disastrous for a number of small dams in the Adirondack Mountains region of New York State. In our issue of May 9, 1912, p. 900, we described in some detail the failure of the Dalton Dam at Mineville, Essex Co., N. Y., which occurred on Apr. 23. Other failures which have occurred within the past two months are the Rockport Pond Dam, eight miles west of Port Henry, Essex Co., which failed on Apr. 8; the Moffittsville Dam, on the Saranac River, 20 miles west of Plattsburg, which went out Apr. 7; a small dam on the Au Sable River, near Wilmington, which was carried away the same day, and finally on May 20 the Lincoln Pond Dam, near the Kingdom district, about seven miles west of Westport, Essex Co., N. Y.



RUINS OF THE LINCOLN POND DAM, ESSEX CO., N. Y.

This last dam is located on the Black River, a tributary of the Bouquet River, and forms a storage for a pond used in a hydro-electric plant furnishing power to the town of Westport, to Mineville, and to the mines at that place, which were also partly supplied by the Dalton Dam noted above. On Apr. 20, 1909, a dam at this location, with a rubble concrete main section and wooden framework side wings went out under a pressure of a flood in the river and caused a damage of about $70,000.

Soon thereafter the owner, G. F. Payne, of Elizabethtown, N. Y., started construction of the new dam which failed last month. This dam consisted of a main wall 100 ft. long crossing the stream at an angle of about 30° with the current and two wings, one at the south side 100 ft. long and one at the north side 50 ft. long reaching back at slight angles to the main section. The main section, all of which was a spillway, was 25 ft. high, 2½ ft. wide at the top and spreading out at equal angles on upper and lower faces to a width of 11½ ft. at the solid rock foundation. The dam was built of cobble stones, cement and gravel and was reinforced only at the connection of the north wing with the main section by four pieces of 1-in. wire cable 12 ft. long. So far as we can learn there were no plans for the dam nor no engineer connected with its construction and a local engineer reports that very little consideration was given to any of the hydraulic problems involved.

There had been heavy rains just previous to the last failure and the reservoir was very full. The flood wrecked two power houses, a few farm buildings, and caused considerable damage to sawmill and to the adjacent farm land. No lives were lost in the collapse. The accompanying view shows the remains of the dam after the flood, looking upstream, the right-hand side being the north.

The data regarding the Lincoln Pond Dam is taken from a report by J. M. De Long, an engineer of Elizabethtown, N. Y.

Hydraulic Speed-Change Gearing is to be applied to a large ship by the Hamburg-America Line, according to a note reproduced in the "Zeitschrift des Vereines deutscher Ingenieure" of May 4, 1912. The company is reported to have ordered a 22,000-ton ship of the Vulcan Werke of Hamburg, Germany, with drive by two steam turbines totaling 13,000 hp., and a Föttinger hydraulic-turbine gear for reducing the drive speed of 800 r.p.m. to 160 r.p.m., at guaranteed efficiency of 88%.

The Cleveland Convention of the American Society of Mechanical Engineers

The most largely attended spring convention ever held by the American Society of Mechanical Engineers took place last week in Cleveland, Ohio. The number of members and guests registered in attendance exceeded 550. A large local committee, composed of the members of the Society resident in Cleveland and vicinity and headed by Ambrose Swasey, Past-President of the Society, as Chairman, had arranged for the hospitable entertainment of the visiting members. Their careful forethought and attention to detail made the Cleveland meeting from the point of view of social enjoyment among the most successful that the Society had ever held.

Those arriving at Cleveland on Tuesday afternoon were welcomed by Mr. and Mrs. Swasey at an informal reception at their residence on Euclid Avenue.

One of Cleveland's most prominent commercial organizations is its Chamber of Commerce. Active in this organization are many of the engineering manufacturers of Cleveland and Mr. Swasey is now the President of the Chamber. The headquarters and professional sessions of the Society during the Cleveland meeting were held in the Chamber of Commerce Bldg.

At the business session of the Society, held at 10 a.m., Wednesday, a special effort had been made to bring together as many as possible of the past-presidents of the Society and there were on the platform when the meeting opened six past-presidents, the list including Capt. R. W. Hunt, who was president in 1891; S. T. Wellman, of Cleveland, who was president in 1901; Ambrose Swasey, president in 1904, and Messrs. Jesse M. Smith, George Westinghouse and Col. E. D. Meier, who have held the presidency during the last three years. Mr. Swasey, in opening the meeting, read letters from the two oldest living past-presidents of the Society, E. D. Leavitt, who was president in 1883, and Prof. John E. Sweet, president in 1884. Both of these were prevented by illness from being present, but Mr. Swasey stated that Prof. Sweet is usually in good health and has recently completed, with his wife, a tour around the world.

At this session some interesting reminiscences were presented by Mr. Swasey regarding the first Cleveland meeting of the Society, which was held 29 years ago. At that time the total membership of the Society, including those elected at the Cleveland meeting, was only 413. The present membership, including the election at Cleveland, is in the neighborhood of 4500. At the Cleveland meeting in 1883 announcement was made of the election of Prof. F. R. Hutton as secre-

tary of the Society, and he served in that office during the years of rapid growth until his election as president in 1906. Still another interesting historical event at the Cleveland meeting was the announcement of the conferring of the degree Doctor of Engineering on the president of the Society, E. D. Leavitt, which was, we believe, the first instance of the bestowal of this honorary degree in the United States.

After various interesting reminiscences of the early history of the Society and the prominent men of that earlier day, Mr. Swasey introduced the Mayor of Cleveland, Hon. Newton D. Baker, who gave the visitors a hearty welcome to Cleveland. A brief response was made by Dr. Alexander C. Humphreys, president of the Society, and the business of the morning session was then transacted, which consisted in the report of the tellers of election who had counted the letter ballots for a large number of new members and the report of the Committee on Constitution and By-Laws as to two or three proposed changes in the Society's Constitution and By-Laws. The principal change is the establishment of a new grade of membership, to be known as Associate Member. Under the proposed new arrangement those joining the Society between the ages of 25 and 30 will enter in this grade. Under the new arrangement, therefore, the Society's membership will consist of Juniors between the ages of 21 and 25, Associate Members between the ages of 25 and 30, Members, who join the Society at the age of 30 or over, Honorary Members and Associates. The last-named class is to include those who are able to cooperate in the advancement of mechanical engineering but who are not themselves engineers.

The Society then took up the reading and discussion of professional papers, the session of the main body of the Society being devoted to papers on steam engineering, flour-mill engineering and gold-dredge construction. At the same hour the Gas Power section of the Society met separately and considered papers on natural-gas engineering, carburetors and soft-coal gas producers. At the conclusion of the technical session the visitors were entertained at luncheon.

The afternoon was devoted to excursions to Cleveland manufacturing plants, the members being divided into small parties which visited such of the various plants as interested them. The visiting ladies were entertained by an automobile trip through the park. Following the conclusion of the visits to the various plants, all the guests were taken in automobiles to the Cleveland Country Club, where light refreshments were served and a social hour was enjoyed. On Wednesday evening the members assembled in the Chamber of Commerce Hall, where a lecture was given by Doctor Dayton C. Miller, Professor of Physics in the Case School of Applied Science. Doctor Miller's lecture was on the Photography of Sound Waves, and was especially notable for the exhibition of some of the latest original work performed by Prof. Miller and his associates in the photography of sound waves.

Doctor Miller has also devised a new instrument known as a "phonodeik." This instrument projects sound waves directly upon a screen, the waves being magnified some 50,000 times, so that they have a vertical amplitude of several feet. In this way it becomes possible to make visible the sound waves produced by the voice, by any musical instrument or combination, the component parts of speech such as the vowel sounds and many other interesting features in connection with sound-wave studies. By projecting the moving beam of light on a sensitized surface, it is possible also to take photographs and record in permanent form the sound waves produced by any instrument. The lecture was one of the most interesting forms of entertainment which the Society has ever enjoyed at any of its meetings.

At the professional session of Thursday forenoon the time was chiefly devoted to a couple of important papers by Thomas D. West, of Cleveland, describing new processes for producing chill in cast iron and methods of testing the chill. Mr. West is well known as one of the most industrious workers in the field of research in connection with cast iron. Unfortunately, the brief time available for the session permitted little discussion of Mr. West's paper or of two following papers by Prof. W. F. Durand and William F. Uhl on speed regulation in hydroelectric plants.

On Thursday afternoon propitious weather added to the pleasure of a steamboat excursion on Lake Erie by the steamer "Eastland." The steamer, which is a large excursion vessel, went out of the Cleveland harbor and then eastward along the lake shore, passed along the entire water front of Cleveland and onward for some 20 miles before turning round and retracing her course. In the evening the visitors were entertained by a reception and dance at the Cleveland Colonial Club. At the concluding session of the meeting on Friday morning, the topic of most interest taken up was the design of large steam turbines. This brought about the most active discussion of the meeting and brought forward the important changes which are now taking place in steam-turbine design. A farewell luncheon was then given to the visitors in the Chamber of Commerce Hall and the afternoon was spent in an excursion to Akron, Ohio, where the plants of the Goodrich Rubber Co. and the Wellman-Seaver-Morgan Co. were visited. It is at the latter works that the enormous hydraulic turbines for the great water-power plant at Keokuk, Iowa, are being constructed. The comparatively low head under which this plant is to be operated and the large size of the unit, 10,000 hp., makes these machines among the very largest turbines ever built. Their design and construction involves many problems of great engineering interest.

The Cleveland meeting of the Society will go down in its annals as one of the most valuable and enjoyable that the Society has ever held. It is announced that the convention of the spring of 1913 will probably be held in Baltimore, Md.

Vanadium in Iron and Steel Castings*

By G. L. Norris†

The use of vanadium in gray-iron castings has been limited when compared to its use in steel castings, although the past year has shown a marked increase, and its use in certain classes of castings has become well established. In the case of vanadium we are dealing with a metal of fairly high price, and its use in the manufacture of cast iron naturally will be confined to the classes of work that can stand a material increase in cost in return for the special qualities obtained. The addition of 0.1% of vanadium to cast iron, at the present price of $5 per lb., means an increase of ½c. per lb. for the iron in the ladle, and necessitates an increase in selling price of ¼c. to 1c. per lb. at least, to cover losses due to scrap, gates, sprues, etc.

While vanadium has a strong affinity for oxygen and nitrogen and is partly used up by combining with these elements, the primary purpose of adding vanadium to cast iron is not the removal of oxygen and nitrogen. The object of the use of vanadium is to give certain qualities to the iron, and to do this the vanadium must enter into the cast iron as a component part.

Vanadium increases the strength of the cast iron to which it is added from 10 to 25%, depending upon the initial strength of the iron. This increase of strength is due directly to the intensifying effect of the vanadium on the metals present in the cast-iron alloy, such as silicon and manganese, and also by combination with the chemically combined carbon.

It exercises a very strong effect on the grain of the iron, causing a more even distribution of the graphite with consequent greater freedom from both hard and porous spots. This effect is very apparent, vanadium cast-iron fractures showing a finer and more uniform grain. In the case of chilled iron, vanadium produces a deeper, stronger and tougher

*Abstract of a paper read before the American Foundrymen's Association.

†Engineer of Tests, American Vanadium Co., Pittsburgh, Penn.

chill, and one less liable to spall or flake. This chill, however, is not as hard apparently as the more brittle chill of ordinary chilled iron and can be filed and machined more readily.

Vanadium also gives an element of toughness to cast iron, which is very apparent in machining the castings. This toughening effect, together with the uniform fineness of grain or texture due to even distribution of graphite in small flakes, makes vanadium cast iron very superior for such purposes as gas and steam-engine cylinders, valve and piston bushings, piston rings, glass-bottle molds, gears, and castings to withstand heat and internal pressure of fluids and gases without leakage.

Three or four years ago the New York Central lines equipped one of its locomotives with a pair of cast-iron cylinders containing vanadium. The performance of this pair of cylinders over a test period of about two years was so satisfactory that 500 or more locomotives on these lines are now equipped with similar cylinders. The test of the original pair demonstrated that over twice the normal mileage of ordinary cast-iron cylinders could be obtained from such cylinders before reboring. The loss in casting these cylinders was extremely low, no cylinders being scrapped at all for the first 183 locomotives ordered. The same sort of results have been reported by a builder of large gasoline engines for marine use. In this particular case, the number of cylinders formerly lost when tested after machining was excessive, because of porousness of certain sections.

Piston rings and cylinder and valve bushings of cast iron with vanadium have been thoroughly tried out and adopted by a number of leading railroads on account of the greatly increased length of service obtained.

A very interesting application of vanadium has been for glass-bottle molds. These, as you are well aware, are chill castings, and are usually covered with engraving. The iron has to be clean, close and uniform in grain, machineable, and take a good polish. The first cast-iron bottle molds of this kind were made a little over a year ago and proved not only to have a longer life, but it was found possible to increase the speed of the bottle machines, as the glass did not appear to stick to these molds to any extent. This can be readily accounted for by the uniformity of the grain and freedom from mottled spots.

One of the first applications of vanadium to cast iron was in chilled iron rolls for sheet mills. A number of these were made and gave excellent results, some of them showing 50% greater tonnage with one-half the dressing against the regular chilled roll. The question of cost, however, entered in here in an unusual manner. Fully 65 to 70% of the roll breakages are due to accidental causes and no amount of vanadium would insure, for instance, against a roller letting a pair of tongs pass through the rolls.

The following tests are the average for ten consecutive days' work on locomotive cylinders. The transverse tests were made on bars 1 in. square, 12 in. between supports; the bars were machined all over and consequently were absolutely comparable, which is not always the case with bars only brushed or cleaned.

	Transverse Lb.	Tensile Lb.
Plain cast iron.....	2,130	24,225
Cast iron with vanadium	2,318	28,728

This iron has stood 750 lb. water pressure for sections ¾ in. thick. The average chemical analysis of this iron is about as follows:

Combined carbon	0.50
Silicon	1.50
Manganese	0.45
Phosphorus	0.600
Sulphur	0.095

The following tests were supposed to be from iron from the same ladle, before and after adding vanadium, but the chemical analysis shows that such could not have been the case. The difference in composition, however, so far as it influences the physical qualities of the iron, are all in favor of the iron without vanadium. In addition to the bars for tensile test, chill blocks were cast to show the effect of vanadium on the depth of the chill.

CHEMICAL COMPOSITION

	Without vanadium	With vanadium
Graphitic carbon	2.34	2.48
Combined carbon	0.79	0.71
Silicon	1.83	2.21
Manganese	0.43	0.424
Phosphorus	0.508	0.546
Sulphur	0.102	0.071
Vanadium	....	0.056

PHYSICAL TESTS

	Without vanadium	With vanadium
Tensile strength...	34,560	35,600
Depth of chill.....	no white chill	⅛ in. white chill

Size of chill-test block 4½ in. square by 1½ in. thick. The difference in machining quality of the two irons was decidedly in favor of that containing vanadium.

I need hardly mention that the cast iron treated with vanadium should be at least approximately of the proper composition for the particular class of work to which it is intended. The usual amount of vanadium added to cast iron is 0.1% for cupola melted iron, equivalent to about 5 oz. of ferro-vanadium for each 100 lb. Some foundries advocate the use of a higher percentage, up to 15%, which is about as much as can be conveniently added in the ladle. As low a percentage as 0.05% will produce distinctive effects.

Owing to the high melting point of vanadium and the limited reserve heat available in a ladle of iron, it is advisable to use the alloy in a finely crushed condition, or even powdered when the amount of iron treated is small, and to use an alloy of low melting point. The iron should be tapped out as hot as possible and a ladle used that has just been emptied in order to conserve as much heat as possible.

After the bottom of the ladle is covered with a few inches of iron, the finely crushed or powdered ferro-vanadium is added by sprinkling on the stream as it flows down the spout to the ladle; in this way advantage is taken of all the available heat and also of the mixing effect of the stream as it strikes the iron in the ladle. After the vanadium is added, the contents of the ladle should be well stirred and allowed to stand a few moments in order to insure thorough incorporation and complete reaction.

In the case of the higher grade air-furnace iron, with its reserve of available furnace heat, the procedure is very simple; after the charge is melted, and 15 to 20 minutes before tapping, the ferro-vanadium is added and the bath well stirred or rabbled. The addition of 0.18 to 0.20% vanadium is recommended in this case, equivalent to 10 to 11 oz. of 35% ferro-vanadium per 100 lb. of metal. The American Vanadium Co. has lately developed a ferro-vanadium containing about 30% to 35% vanadium, 10% to 15% silicon, 5% to 10% manganese and 2% to 5% aluminum, which melts and dissolves readily in molten cast iron, and has been giving very satisfactory results.

Steel Castings

The effect of vanadium in plain carbon-steel castings is to increase the elastic limit about 30%, giving a much higher proportion of available strength for the same ultimate strength. In addition, the vanadium increases the dynamic strength or power to withstand repeated and alternating stresses, fully 50%. I would emphasize here, again, the fact that it is the effect of vanadium as a component part of the steel that is particularly desired, and not the scavenging or cleansing properties. One purpose of calling attention emphatically to this is because from time to time, one hears of unfavorable reports of vanadium steel, which upon examination proved to contain none of this element, the explanation given the purchaser being that the property of vanadium was solely that of a scavenger and it was not essential that any remain in the steel.

Prof. Arnold, of Sheffield, is of the opinion that vanadium is undoubtedly the element which, together with carbon, acts with the greatest intensity in the way of improving alloys of iron, that is to say in very small percentages; and Prof. Arnold was also of the opinion that vanadium has not only a chemical but

also a physical influence in promoting the even distribution of the carbon and retarding constitutional segregation.

One of the earliest applications of vanadium steel was for locomotive frame castings. For years these frames had been made of hammered wrought iron. Then with the advent of steel castings this material became commonly used. With the great increase in size and weight of locomotives in recent years, the increasing failures of frames became a very serious matter. The great increase in elastic limit and resistance to repeated stresses, made possible by the addition of a small percentage of vanadium to steel castings, at once appealed to the motive-power men. Trial frames were put to test under locomotives that had records as chronic frame breakers, and with such remarkable freedom from failures that a number of roads immediately adopted cast-steel frames with vanadium as standard. There are now in the neighborhood of 1500 frames in service and the known failures are insignificant, less than half a dozen.

The following comparative tests from plain carbon and cast-steel frames with vanadium in them show very clearly the effect of vanadium. The steels were made by the same concern, from the same character of stock.

CHEMICAL COMPOSITION

	A	B
Carbon	0.25	0.235
Phosphorous	0.036	0.047
Manganese	0.60	0.575
Sulphur	0.024	0.030
Silicon	0.23	0.25
Vanadium	none	0.185

PHYSICAL TESTS

	Elastic limit	Ultimate strength	Elongation % in 2 in.	Reduction of area
A....	37,160	71,700	33.0	48.2
	36,710	70,180	31.5	52.8
B....	45,660	76,620	27.5	51.1
	42,590	78,200	31.0	51.8

A—Alternating impact ¼ in. throw—average 1918.
B—Alternating impact ¼ in. throw—average 2952.

The alternating impact tests are made on a bar ⅜ in. diameter and effective test length 4 in.; the bar is held in a vise and the free end moves rapidly back and forth by means of a slotted hammer. In the case of the above tests, the rate of alternations was about 600 per minute, and the movement was ¼ in. either way from the normal position, or a total movement of ½ in.

Steel castings containing vanadium should never be used without annealing. In the unannealed state they are more brittle than plain carbon-steel castings. In annealing it is found that such castings require a somewhat higher temperature than ordinary steel castings. For locomotive castings and similar work, a temperature of at least 1500° F. is required, and preferably 1560° F.

Vanadium steel has been used in a great variety of castings, especially those subjected to repeated stresses and wear. It would be useless to attempt to enumerate them all, but I would call attention to two classes of castings that are giving remarkable results. These are rolling-mill pinions and gears, and automobile castings. Rolling-mill pinions have shown two to three times the life of carbon-steel pinions and 1½ to 2½ times the life of nickel-steel pinions.

While I would not want to recommend the replacement of drop forgings by any steel castings in the construction of an automobile, yet the record of castings of vanadium steel in certain automobiles has been remarkable. These are made regularly by all the various steel making processes, and present no particular difficulty. The principal requirement being to have the steel clean and free from oxides, and the slag in proper condition in the case of open-hearth steel. The cleansing of the steel from oxides by manganese and silicon is a well understood operation and need not be gone into here in detail. The vanadium in the form of ferro-vanadium should be the last addition made, and a little time allowed after the addition of manganese and silicon for these elements to react.

In the case of crucible-steel castings, the general practice is to add the ferro-vanadium to the crucible with the mix, and melt down. The amount of vanadium that has been found most satisfactory to add is 0.25%, or 2½ lb. to each 1000 lb. of steel. The amount of vanadium remaining in the steel from this addition is usually 0.18 to 0.20%. In the case of crucible and acid openhearth steel the scrap should be saved, as in remelting a considerable portion, about 20 to 25%, of the vanadium is not lost, and advantage should be taken of this fact.

An Eruption of Mount Colima, Mexico, in the State of Jalisco, is reported in press dispatches, dated June 3. Two new craters have formed on the western slope of the volcano some distance below the summit, according to reports, and great streams of lava are flowing down the mountain sides. The natives in the vicinity for the most part heeded the advance signs of the outbreak and escaped safely from the danger zone.

A Sight-Seeing Automobile Tipped over, May 31, on the Hoffman Boulevard, in the Borough of Queens, New York City. One man was killed and 14 other persons were badly injured.

A Picture Theater Fire in Spain, at Villa Real, Castellon Province, May 27, resulted in the death of 103 people. Reports state that the theater, which was constructed entirely of wood, had only recently been opened to the public. The fire started in the film of the motion-picture machine, which was mounted directly over the main entrance. The doors of this entrance, which was also the main exit, opened inward and were held shut by the crowd of people crushing against them in their efforts to escape.

A Grade Crossing Accident wrecked an automobile at Centreton, Ind., May 26, on the track of the Martinsville division of the Indianapolis, Terre Haute & Eastern Traction Co. Four persons in the automobile were killed. The accident is ascribed to the stalling of the automobile engine as it was crossing the tracks.

A Tornado in Oklahoma, May 27, caused the death of seven persons and the injury of many others at Skiacook, 18 miles northwest of Tulsa. The damage to property is estimated at $75,000, a large part of which is accounted for in the destruction of oil derricks in the vicinity of the town. Reports state that three storm cellars in Skiacook gave safe refuge to 75 people.

A Failure of a Concrete Building occurred at Indianapolis two or three weeks ago, consisting of the collapse of a small section of the roof above the fourth floor of the Cole Motor Car Co.'s building. One man was killed but the property damage was slight. We are informed that the coroner and the city building superintendent have been unable to fix the blame, and seem to have considered the construction good. The only excuse thus far given is that there were cinders on the roof that might have become saturated and thus overloaded it. This explanation, of course, is very far from satisfactory, but an engineer who wished to examine the failure was refused admittance. The work was under construction by Halstead & Moore.

An Aerial Swing Accident at Steeplechase Park, Coney Island, N. Y., May 26, resulted in the injury of six persons riding in one of the cars of the swing. The swing consists of a tower from the upper part of which project radiating arms from which the passenger cars or boats are suspended by cables. The arms are revolved when the swing is in action, and the centrifugal force causes the boats to rise until the cables supporting them are nearly horizontal. Swings of this type are in use at amusement parks all over the country.

Press reports state that the accident occurred just as the swing had been brought up to its maximum speed. The cables at one end of one of the boats gave way and the six passengers were spilled out on the ground.

An examination of this swing was made in September, 1910, by inspectors of the Brooklyn Bureau of Buildings. The report based on this examination states that the swing was built of 4-in. angle iron. The supporting tower was about 65 ft. in height, with a base 15x15 ft., and tapering toward the top. The foundation consisted of four 8-in. diameter piles on which rested a frame of 4x12-in. yellow-pine timbers. The six arms or outriggers from which the boats were hung were at a height of 50 ft., and were spaced equal distances apart. Iron rods from the top of the tower were fastened to the extreme outer ends of the outriggers. The capacity of the six boats was eight persons each.

The report states that some of the piles supporting the structure were decayed and that many of the cables carrying the boats had become rusted and were pitted with rust and were unpainted. A drawing submitted by the owner of the swing, but not confirmed by the building inspectors, gave the size of the cables, two of which are shown at each end of each boat, as ⅝ in.

The swing was erected without notice to or permit from the Bureau of Buildings, and, although it stood within the Borough of Brooklyn, and therefore within the jurisdiction of the Bureau, all efforts to stop its operation by injunction until changes recommended by the Bureau had been made were without result. The same is true of many other

structures at the Coney Island amusement parks, the courts apparently considering such structures exempt from the ordinary building laws.

The Austin Dam Prosecution against George C. Bayless, President, and F. M. Hamlin, Superintendent, of the former Bayless Pulp & Paper Co., who are under indictment charged with manslaughter on account of the failure of the Austin dam on Sept. 30, 1911, is now shifted to another county. The indicted men petitioned the Supreme Court of Pennsylvania for a change of venue, and in compliance their trial has been shifted from Potter County to Tioga County. They alleged that the inflamed condition of the public mind in Potter County would make it impossible for them to get a fair and unbiased trial.

Elevator Tests—The following rules for tests of new or reconstructed elevators have been prepared by the Bureau of Buildings of Manhattan Borough, New York:

1. All passenger or freight elevators hereafter installed in any building or on which the power or type of machine has been altered shall be subjected to the regulation tests and inspection and a formal approval obtained from the Superintendent of Buildings before the same shall be placed in service.
2. All types of electric elevators operated by either direct- or alternating-current machines, and elevators operated by either vertical or horizontal hydraulic machines, belted machines or steam machines and used for passenger or passenger and freight service shall be tested as follows:
   (a) The car shall be loaded to its specified maximum capacity and operated up and down the shaft several times at the required speed as specified in the elevator application. In these test runs, the upper and lower automatics or "limits" shall be observed for proper operation; and the car shall be stopped at various points in the shaft to test the proper action of the machine brake.
   (b) The car with maximum load shall be run to the top landing and allowed to descend at a speed beyond normal or at "runaway" speed. In this test, the governor or speed regulator should automatically operate the safety device on the car, bring the same to a stop in the shaft and cause the lifting cables to become slack, thereby operating the slack cable device and automatically stopping the machine.
3. All types of above elevator used exclusively as freight elevators in garages, stables, car barns, or warehouses, with a platform of large area and operated normally at slow speed, shall be tested as follows:
   (a) The car shall be loaded to its specified maximum capacity and operated up and down the shaft several times at the required speed as specified in the elevator application. In these test runs, the upper and lower automatics or "limits" shall be observed for proper operation; and the car shall be stopped at various points in the shaft to test the proper action of the machine brake.
   (b) The car with maximum load shall be run to the top landing and made to descend at normal speed. The governor or speed regulator when thrown in at this normal speed should automatically set the safety device in the car, bring it to a stop in the shaft, thereby operating the slack cable device and automatically stopping the machine.
4. All types of direct plunger elevators and short-rise freight elevators, in which no governor safeties are installed, shall be tested as follows:
   The car with maximum load shall be operated up and down the shaft several times to test the required lifting capacity at the speed as specified in the elevator application. In this test, the upper and lower automatics should operate satisfactorily.

These rules are put out as tentative only, for the present. Before they are announced as final, any criticisms received will have consideration; they may be sent to the Superintendent of Buildings, R. P. Miller, 220 Fourth Ave., New York City.

A Reservoir Break did considerable damage at Ansonia, Conn., on May 28, 1912. The power reservoir of the Ansonia Land & Water Power Co. failed by undermining of a recently constructed concrete retaining-wall. This wall was about 150 ft. long, 20 ft. high above ground, with foundation about 15 ft. below ground. The water back of the wall was about 20 ft. deep, the flow line being about 3 ft. below top of wall. The ends of the wall extended into the old earth embankment, for a part of which the wall had recently been substituted. The retaining-wall served as a backbone for a number of forebays from which the canal water is distributed by penstocks to various mills. The water worked its way under the foundation about the middle of the length of the wall, and washed out a hole some 25 ft. square. The outrushing water swept through the copper mill of the American Brass Co. and flooded the southerly part of the business section of Ansonia. The damage is estimated at from $100,000 to $200,000. The wall itself is not damaged, although some of the forebay wing-walls fell into the breach. The accident is supposed to have been caused by a vein of sand underlying the foundation. A fuller report is expected shortly.

Personals

Mr. C. O. Vandevanter, M. Am. Soc. C. E., a consulting engineer of Leesburg, Va., and formerly of Baltimore, Md., has been appointed Assistant City Engineer of Baltimore.

Dr. Edwin Boone Craighead, President of Tulane University, in Louisiana, has been chosen President of the University of Montana, at Missoula, Mont., succeeding Dr. C. D. Duniway, resigned.

Mr. William Z. Price, Mining Engineer of the Tennessee Coal, Iron & R.R. Co., at Birmingham, Ala., has resigned to accept a similar position with the Pittsburgh Coal Co., at Pittsburgh, Penn.

Mr. W. C. Perry has been appointed Chief Engineer of the Davis Coal & Coke Co., at Cumberland, Md. Mr. Perry has been in the engineering department of the company for a number of years.

Mr. W. W. Crosby, M. Am. Soc. C. E., Chief Engineer of the Maryland Roads Commission, has resigned to engage in private practice as a consulting engineer, specializing in highway and bridge work.

Mr. Henry G. Shirley, M. Am. Soc. C. E., Roads Engineer of Baltimore County, Md., has been appointed Chief Engineer of the Maryland Roads Commission, succeeding Mr. W. W. Crosby, resigned.

Mr. Paul Barnard, Supervisor of Track of the Chesapeake & Ohio Ry., at Richmond, Ind., has resigned to accept a position in the engineering department of the Grand Trunk Pacific Ry. at Port Arthur, Ont.

Mr. John J. Porter, M. Am. Inst. M. E., has resigned his professorship at the University of Cincinnati and will devote his whole time to practice as a consulting metallurgical and chemical engineer, with headquarters at Staunton, Va.

Mr. Paul A. Seurot, M. Am. Soc. C. E., has been appointed Canadian representative of Jacobs & Davies, Inc., Consulting Engineers, of New York City and London. The Canadian headquarters of the firm will be at 263 St. James St., Montreal, Que.

Mr. F. A. Naramore, formerly with Emil Schacht & Son, Architects, of Portland, Ore., has been appointed Superintendent of Properties of the Portland public schools. He will have charge of the maintenance of existing buildings and grounds and the design and erection of new structures.

Mr. Albert E. Clift, formerly General Superintendent of the Illinois Central R.R. southern lines, at New Orleans, La., has been promoted to be General Superintendent of the lines north of the Ohio River, with headquarters at Chicago, Ill., succeeding Mr. R. W. Baxter, resigned, as noted elsewhere in these columns.

Mr. Walter H. Flynn, Master Mechanic of the Michigan Central R.R., at St. Thomas, Ont., has been promoted to be Superintendent of Motive Power, with headquarters at Detroit, Mich., succeeding Mr. E. D. Bronner, promoted. Mr. E. B. Webb, now Master Mechanic at Michigan City, Ind., succeeds Mr. Flynn at St. Thomas.

Mr. John F. Porterfield, formerly Superintendent of the Illinois Central R.R. at Carbondale, Ill., has been appointed General Superintendent of the southern lines with headquarters at New Orleans, La., succeeding Mr. A. E. Clift, promoted. Mr. Porterfield began railway work in 1883 as a messenger boy with the Illinois Central R.R.

Mr. E. I. Bowen, Assoc. M. Am. Soc. C. E., formerly Division Superintendent of the Erie R.R. at Susquehanna, Penn., has been appointed Division Superintendent at Rochester, N. Y., and also Superintendent of the Bath & Hammondsport and the Lake Keuka Navigation Co. Mr. Bowen was at one time Division Engineer of the New York, Lake Erie & Western R.R., now a part of the Erie R.R.

Mr. A. Merritt Taylor, President of the Philadelphia & West Chester Traction Co., has been selected by the Department of Public Works of Philadelphia, Penn., to investigate the problems of improved transit facilities for the city and its suburbs, under the title of Transit Commissioner. Mr. Taylor has accepted the position upon condition that he may serve without compensation except for personal expenditures entailed by his work as Commissioner. Mr. Taylor is not a technical man or an engineer but a successful street railway financier and executive.

Mr. William L. Derr, Steam Railroad Inspector for the Public Service Commission of New York State, Second District, has resigned to become Superintendent of the Omaha-Oelwein division of the Chicago Great Western R.R. Mr. Derr is a graduate of the Polytechnic College of Pennsylvania, at Philadelphia, and formerly was Superintendent and later Chief Engineer of the Erie R.R. He also served for several years as Division Superintendent of the Hartford division of the New York, New Haven & Hartford R.R., and as General Superintendent of the Metropolitan Street Rys. of New York City.

Mr. Carl R. Gray, former President of the Spokane, Portland & Seattle Ry., and other of the Hill lines in Oregon and Washington, has been elected President

of the Great Northern Ry., succeeding Mr. Louis W. Hill. Mr. Gray was born in 1867. After a course at the Arkansas Industrial University he entered the service of the St. Louis & San Francisco R.R. as a telegraph operator, in 1882. He remained in the service of this railway, rising through various grades in the operating department to the position of Senior Vice-President, until April, 1911, when he was chosen to succeed Mr. John F. Stevens as the head of the Hill lines in the Northwest.

Mr. William Wainwright, formerly Vice-President of the Grand Trunk Ry. and recently Acting President, has been appointed First Vice-President of the Grand Trunk Pacific Ry., succeeding Mr. E. J. Chamberlain, whose appointment as President of all the Grand Trunk lines was noted in our issue of last week. Mr. Wainwright was born in Manchester, England, in 1840. After four years' experience in clerical positions on the Manchester, Sheffield & Lincolnshire Ry., he came to Canada and entered the employ of the Grand Trunk Ry., in 1862. He has since served continuously with the Grand Trunk Ry., and has occupied the positions of General Passenger Agent, Assistant General Manager, General Manager, Comptroller, and Vice-President.

Mr. Robert W. Baxter, General Superintendent of the Illinois Central R.R., at Chicago, Ill., has been elected President of the Copper River & Northwestern Ry., of Alaska, and of the Alaska Steamship Co., succeeding Mr. Joseph R. Young, whose appointment as President of the Spokane, Portland & Seattle Ry. was noted in our issue of last week. Mr. Baxter was born in Scotland in 1859. His railway work commenced in 1870, when he was employed as a messenger boy with the Union Pacific Ry. He remained with the Union Pacific until 1890, having served as Superintendent of various divisions. For a year he was Division Superintendent of the Baltimore & Ohio R.R. at Newark, Ohio, and then returned to the Union Pacific Ry. as Superintendent of the Oregon and Washington divisions at Portland, Ore., later becoming General Superintendent of the Pacific division. For a number of years following 1904 he was Division Superintendent of the Lehigh Valley R.R. at Wilkes-Barre, Penn.

Obituary

J. Edwin Jones, a civil engineer and contractor of Boston, Mass., and a former Superintendent of Streets of that city, died at his home in Jamaica Plain, on June 3, aged 67 years.

Philip Morrison, Superintendent of the Boston-Springfield division of the Boston & Albany R.R., at Boston, Mass., died at his home in Waltham, Mass., on May 30. He was 57 years old.

Sydney Thomas Fuller, an old time railway engineer, died at Kennebunk, Maine, on June 2, aged 76 years. In the years following the Civil War he was active in railway building in the South, and later in Mexico, where he was Chief Engineer of some of the earliest railways.

William H. McCord, President of the firm of Post & McCord, contractors, of New York City, died, June 4, at his home in Greenwich, Conn. Mr. McCord was born 60 years ago at Newburgh, N. Y. He was President also of the Irvona Coal & Coke Co., and a director in a number of others, including the Kansas City, Mexico & Orient Ry.

William Edward Athearn, Engineer of Equipment of the Western Union Telegraph Co., New York City, and one of the most experienced telephone and telegraph engineers in the country, died on May 29, at his home in Brooklyn. He was a graduate of Williams College and had been in the employ of the Western Union Telegraph Co. for over 30 years. He was 55 years old, and is survived by a widow, three daughters and two sons.

David Holtz, former Master of Machinery of the Western Maryland R.R., at Union Bridge, Md., died at his home in Baltimore, Md., on May 30. He was born in Baltimore in 1842 and at the age of 14 years became a messenger boy in the machine shops of the Baltimore & Ohio R.R. From this position he rose to that of draftsman. During the Civil War he served 15 months as an assistant engineer in the United States Navy. For eight years following his return to private life he was Chief Draftsman of the Baltimore & Ohio R.R. In 1873 he was appointed Superintendent of Rolling Stock of the New York, Lake Erie & Western R.R., but returned the following year to the Baltimore & Ohio. In 1876 he was appointed Master of Machinery of the Western Maryland R.R. and held this position for more than 30 years.

Daniel Hudson Burnham, Past-President of the American Institute of Architects, designer of many notable buildings in the United States, and famous of late years for his work in the field of city planning, died on June 1, at Heidelberg, Germany, where he had gone to enjoy a much needed vacation.

He was born at Henderson, N. Y., Sept. 4, 1846. His parents removed to Chicago, Ill., in 1856, and there and in Massachusetts his early education was received. He studied architecture in Chicago, and was not a graduate of any university, although in later years he received honorary degrees from Harvard, Yale and Northwestern Universities and the University of Illinois.

In 1872 he became senior member of the firm of Burnham & Root, of Chicago, and since 1891 of D. H. Burnham & Co.

Mr. Burnham was architect for the Rookery, the Masonic Temple, the Great Northern Hotel, the Marshall Field department store, and many other of Chicago's important buildings. He also designed the union passenger station at Washington, D. C., the Wanamaker department stores in New York and Philadelphia and prominent buildings in San Francisco, Cleveland, Buffalo, and many other American cities.

He was Architect and Director of Works of the World's Columbian Exposition at Chicago, 1892-1893. More recently he had been the chairman of the national commission for beautifying the city of Washington, D. C. In recent years he had given much time and thought to city planning and his schemes for improving Manila, P. I., San Francisco, Calif., Chicago, Ill., and Brooklyn, N. Y., have been widely known examples of comprehensive city plans.

Wilbur Wright, who with his brother Orville Wright gained the distinction of first attaining successful aërial flights in a heavier-than-air machine, died from typhoid fever at his home in Dayton, Ohio, on May 30. He was born near Millville, Ind., Apr. 16, 1867. When still a young lad his parents moved to Dayton, Ohio, where he attended the public high school.

In the early days of their careers the two Wright brothers ran a small bicycle repair shop in Dayton. Their first successful experiments with aëroplanes began in 1903, and for five years they experimented in the neighborhood of Dayton, and in North Carolina, during which time no notice was taken of their work.

On May 11, 1908, newspaper correspondents first came upon the two brothers at Kittyhawk, N. C., and on that day a flight of 1.855 miles in 2 min. 38 sec. was observed. The following summer the Wrights went to France, where their work was quickly appreciated and they became famous the world over. Upon their return to America they received a national ovation. Returning to Dayton they established a factory for the manufacture of aëroplanes and an aviation school for training men to operate them in various exhibition flights all over the world. Wilbur Wright ceased flying in public in 1910 and had given his time since chiefly to the commercial and research side of aviation.

One of his most famous flights was during the Hudson-Fulton celebration in New York in 1909, when he flew from Governor's Island in the harbor to Grant's Tomb, Riverside Drive, and back again, a distance of 21 miles in 33 min. 33 sec.

Wilbur Wright has been described as modest and reticent to a fault, and certain it is that he never sought publicity or gloried in his triumphs.

Engineering Societies

COMING MEETINGS

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 10-14. Annual meeting at Seattle, Wash. Secy., T. C. Martin, 29 West 39th St., New York.

MASTER CAR BUILDERS' ASSOCIATION.
June 12-14. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

CANADIAN ELECTRICAL ASSOCIATION.
June 19-21. Annual meeting at Ottawa, Ont. Secy., T. S. Young, 220 King St., West, Toronto, Ont.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 25-28. Annual convention at Boston, Mass. Secy., F. L. Hutchison, 33 West 39th St., New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 25-28. Annual convention at Seattle, Wash. Secy., C. W. Hunt, 220 West 57th St., New York.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 26-28. Annual meeting at Boston, Mass. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS.
June 27-29. Summer meeting at Detroit, Mich. Secy., C. F. Clarkson, 1451 Broadway, New York.

NATIONAL MUNICIPAL LEAGUE.
July 8-12. Annual meeting at Los Angeles, Calif. Secy., C. R. Woodruff, North American Bldg., Philadelphia, Penn.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 11-12. Summer meeting at Detroit, Mich. Secy., W. W. Macon, 29 West 39th St., New York.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 16-19. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.